

J A G U A R U N I V E R S I T



AN AUTOMOTIVE LEARNING EXPERIENCE

V6 / V8 ENGINE REPAIR

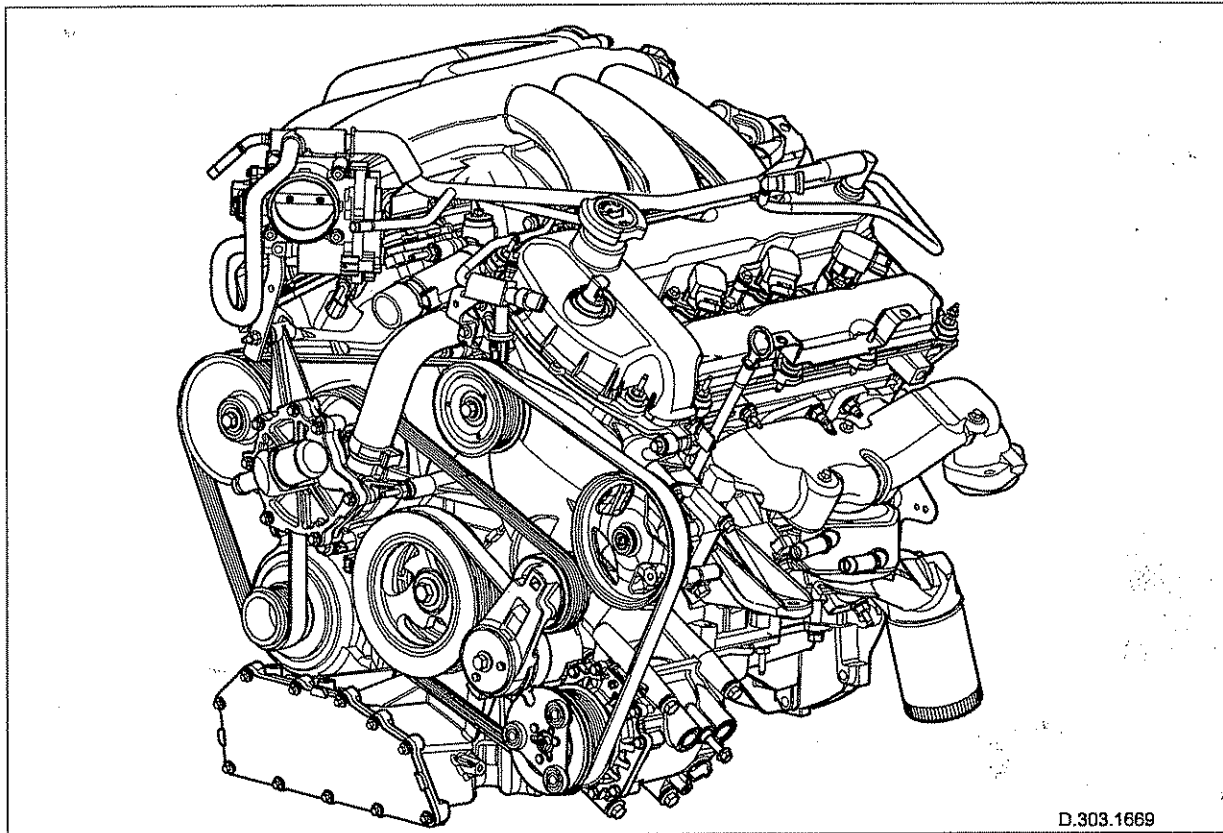
COURSE CODE: 168

JAGUAR

UNIVERSITY

V6 ENGINE

The AJ-V6 3.0 litre (AJ-63) engine has been designed and developed by engineers at Jaguar's Whitley Engineering Centre. They have produced a class-leading powertrain for the entry level luxury saloon segment whilst maintaining Jaguar's reputation for refined power. The V6 engine is manufactured and assembled at the Cleveland engine plant in Ohio, USA. Specifying the AJ-V6 3.0 litre engine widens the new XJ range appeal and accesses a new niche within its market sector.



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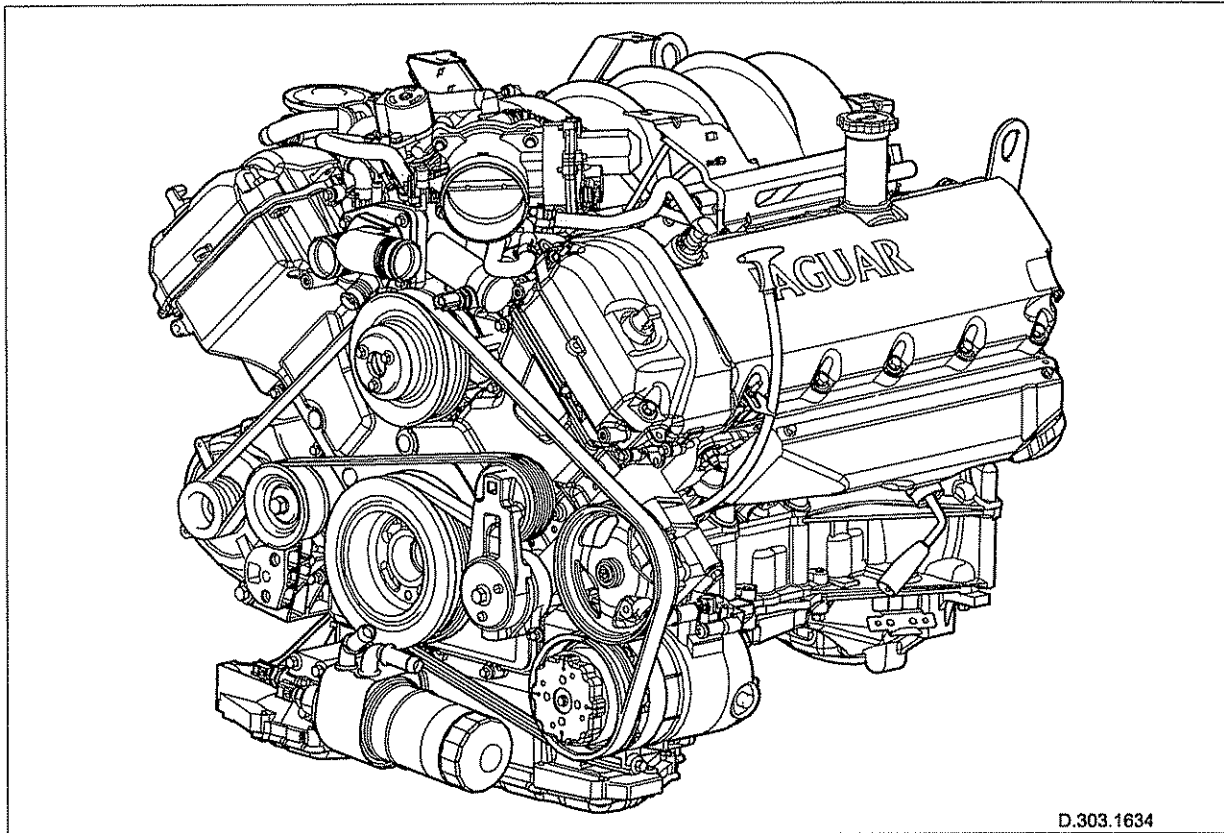
AJ-63 V6 engine

AJ-V6 History

MY and Model	Engine	Feature
1999.25MY S-TYPE	AJ-60	New engine designed for the S-TYPE - Running changes: Chain size reduced to 8mm New oil pump Die cast oil pan in lieu of sand cast (metal plate bolted on the front) New oil cooler Cast camshafts and steel shims At 2001 MY Fuel rail damper ZF power steering pump
2001.5MY X-TYPE	AJ-61	2.5 litre capacity engine Continuously variable valve timing Magnesium camshaft covers Denso engine management system New inlet manifold Rear driven water pump New oil pan New front end accessory drive belt (FEAD)
2002MY 2.0 X-TYPE	AJ-81	New intake manifold Throttle cable
2002.5MY S-TYPE	AJ-62	New intake manifold New left hand camshaft cover New timing cover
2003MY The new XJ range	AJ-63	New A/C compressor and mounting bracket New FEAD belt

Engine identification

- An engine identification code tag is located on the front cover assembly
- Main bearing codes are located at the rear face of the cylinder block and on the rear face of the crankshaft flange
- The engine number is stamped on the side of the bedplate at the assembly plant



D.303.1634

4.2 NA V8 engine

V8 History

MY and MODEL	ENGINE	FEATURE
97MY XK	AJ-26 4.0L	Throttle housing with vacuum unit Throttle cable (mechanical guard) Centre fed injectors
98MY XJ	AJ-26 4.0L - 3.2L and 4.0L S/C	N/A as 97MY XK - new oil pump for all variants S/C - no VVT, dished pistons, new head gaskets, new inlet cam sprockets 3.2 - no VVT, new crankshaft, new con rods, new domed pistons, new intake camshafts
98.75MY XJ / XK	AJ-26 4.0L	S/C fitted to XKR - carry over components used from 98MY XJ XJ ECM used

ENGINE DEVELOPMENT

MY and MODEL	ENGINE	FEATURE
99MY XJ / XK	AJ-27 4.0L N/A only	New inlet manifold with air assist, new throttle housing with full authority throttle, continually variable valve timing (helical gear) new camshafts, pistons and lubrication system, new engine sensors - four lobe camshaft sensor ring on N/A versions and one lobe sensor on S/C versions AJ-26 S/C - takes some AJ-27 mechanical components to rationalise production
99.25MY S-TYPE	AJ-28	New inlet manifold, throttle centrally mounted, new electronic throttle, continually variable valve timing, air assist, new engine sensors (PTEC system), new returnless fuel system, five lobe camshaft sensor ring, modified sump and oil cooler, modified front end ancillary drive belt and components.
2000MY XJ / XK	AJ-27	EOBD introduced Steel liners in lieu of nikasil (2001MY) Multi-layer steel head gasket (2001MY)
2002MY XJ / XK & S-TYPE	AJ-27 /AJ-28 Hybrid	Crank pin diameter reduced from 56mm to 53mm Con-rod changed to match new crank New inverted tooth primary chain and sprocket New oil pump
2002.5MY S-TYPE	AJ-33 4.2 N/A 300bhp – 4.2 S/C 400 bhp	Swept volume increased Modified cylinder block Engine id now in two positions in lieu of three Structural changes to the bedplate New crankshaft New pistons (forged on the S/C with oil cooling) New connecting rods New cylinder heads New camshaft covers Modified front cover Carry over inverted tooth primary chain and sprockets New oil pump New vane type VVT unit (similar to V6) New Denso EMS (as per X-TYPE)
2003MY The new XJ range	AJ -33 4.2L NA 4.2L S/C and 3.5L	4.2 - as per S-TYPE 4.2 engine 3.5 - new crankshaft - new con rods - new pistons
New 2003 XK range	AJ-34	Redesigned intake and throttle position for vehicle fitment, Hybrid AJ-27 oil pan

ENGINE DEVELOPMENT



The new engines were first seen in a 4.2 litre version only in the 2002.5MY S-TYPE and have been designed and developed by Jaguar engineers at Whitley and are manufactured and assembled at the Bridgend Engine Plant.

The new AJ-V8 3.5 litre (AJ-33) engine replaces the 3.2 litre engine and widens the range of V8 engines to embrace the lower market sector and will provide the smoothness and refinement which has become the hallmark of the Jaguar V8 engine range.

The new AJ-V8 4.2 litre (AJ-33) engine is an upgrade of the Jaguar AJ-V8 4.0 litre engine .

The uprated and improved 4.2 litre engines produce better performance, economy and greater refinement than its 4.0 litre predecessors.

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V6/V8 Engine Repair

This publication is intended for instructional purposes only. Always refer to the appropriate Jaguar Service publication for specific details and procedures.

 WARNING: WHILE SERVICING AND TESTING VEHICLES AND VEHICLE SYSTEMS, TAKE ALL NECESSARY SAFETY PRECAUTIONS TO PREVENT THE POSSIBILITY OF BODILY INJURY OR DEATH.

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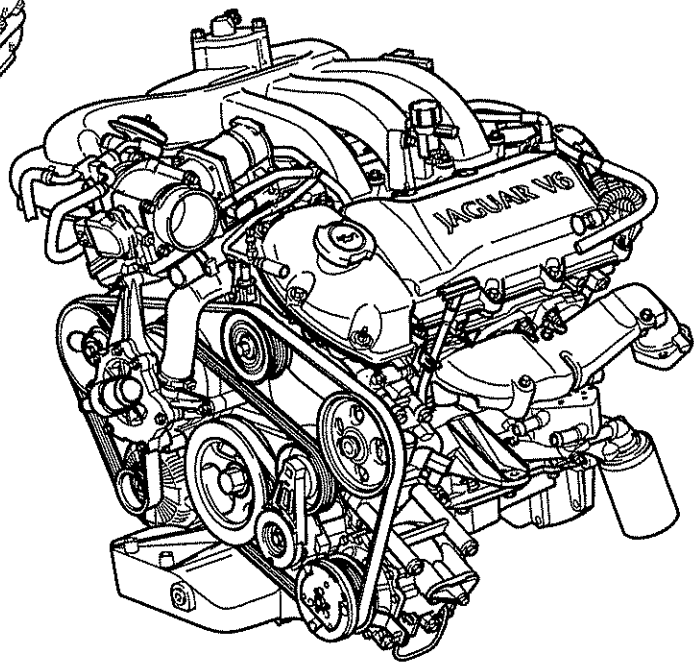
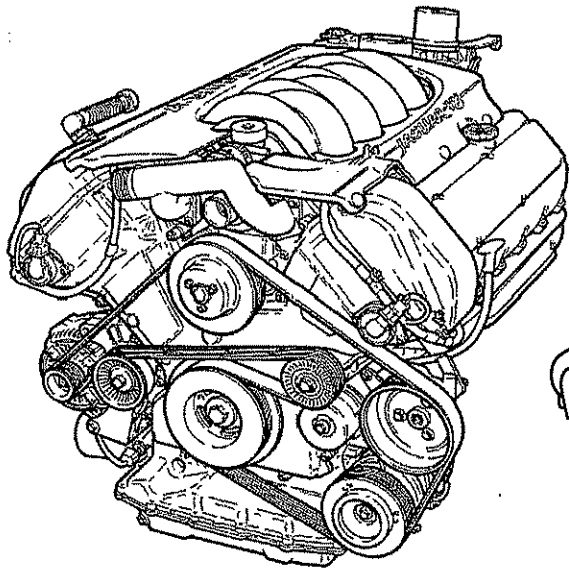
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JAGUAR SERVICE TRAINING

AJ-V6/V8
ENGINE REPAIR



Service Training Course 168

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Objectives

At the completion of Jaguar Service Training Course 168, you will be able to:

- Identify engine components of Jaguar AJ V6 and V8 engines.
- Diagnose Jaguar AJ V6 and V8 engine mechanical problems
- Describe Jaguar AJ V6 and V8 engine overhaul procedures
- Disassemble Jaguar AJ V6 and V8 engines
- Re-assemble Jaguar AJ V6 and V8 engines
- Carry out AJ V6 and V8 engine valve timing procedures
- Identify Jaguar special tools used for engine repair procedures

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AJV8 Engine Overview

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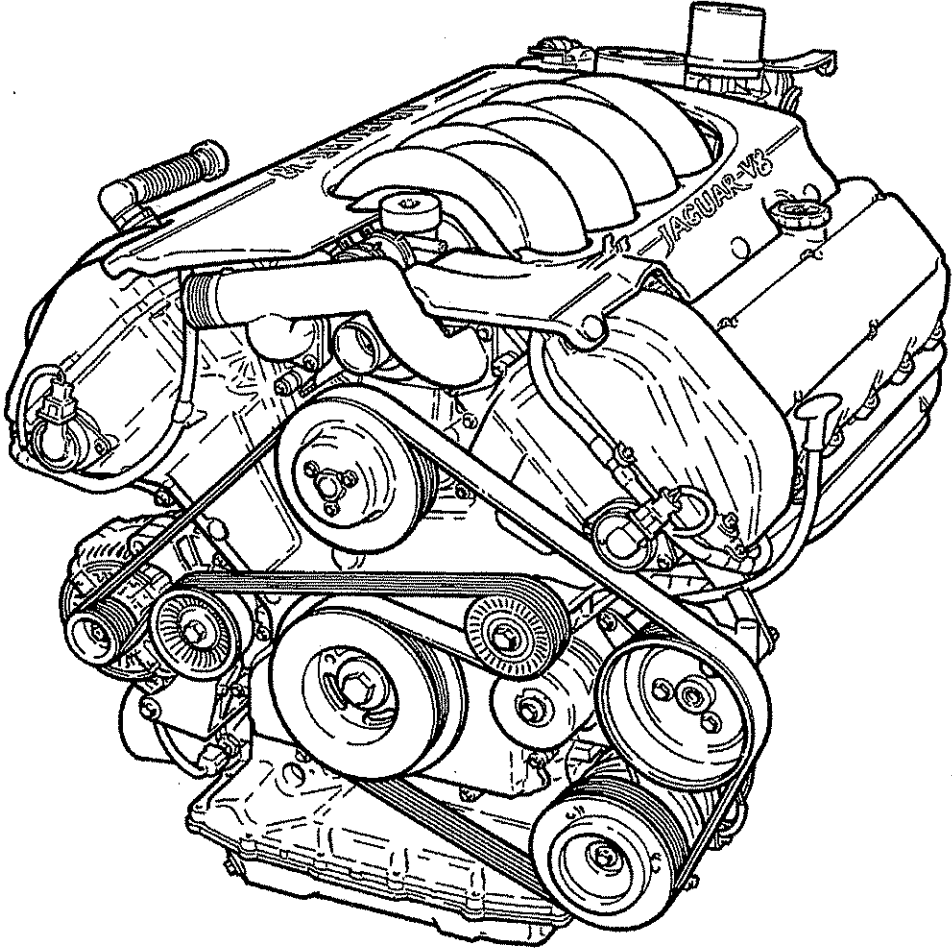
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AJV8 NORMALLY ASPIRATED ENGINE



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AJV8 Engine Overview

Introduction

The AJV8 4.0 liter engine designed to give excellent performance, refinement, economy and to conform to the strictest emission legislation, the engine is available in both normally aspirated (N/A) and supercharged (SC) versions. Weighing only 441 lb(500 lb. SC), the engine is shorter by 12 inches (300 mm) than the AJ16 4.0 liter engine.

Cylinder heads with four valves per cylinder, cylinder block, bed plate and structural sump are all cast aluminum. Cylinders have electroplated bores which reduce piston friction, improve warm-up and oil retention.

A variable valve timing system is equipped for normally aspirated engines to give improved low and high-speed engine performance, excellent idle quality and improved exhaust emissions. The valve gear is chain driven for durability. Low valve overlap improves idle speed, improves combustion efficiency and reduces hydrocarbon emissions.

The normally aspirated intake manifold is a one-piece composite molding with integral fuel rails connecting to the eight side-feed fuel injectors. Combustion air flow into the engine is via an electronic throttle assembly. Throttle movement is controlled by the ECM using sensors in the throttle assembly and an electric throttle motor. Supercharged versions are similar with the belt driven supercharger located downstream of the electronic throttle assembly. The supercharger provides pressurized combustion air to the cylinders through two air to liquid charge air coolers (intercoolers).

The engine has a low volume, high velocity cooling system, which achieves a very fast warm-up with reduced combustion chamber and increased cylinder bore temperatures.

The generator, A/C compressor, and PAS pump are mounted to the cylinder block on rigid cradle supports. A single 7-ribbed belt drives all engine accessories. A separate 8-ribbed belt drives the supercharger, which is bolted to the engine block in the engine vee. Hydraulic engine mounts minimize noise and vibration.

AJV8 Engine Application Summary

XK8 Coupe and Convertible

Model	Model Year	Engine
XK8 Convertible	1997 MY ON	AJV8 4.0L
XK8 Coupe	1997 MY ON	AJV8 4.0L

XJ8 Sedan

Model	Model Year	Engine
XJ8	1998 MY ON	AJV8 4.0L
XJR	1998 MY ON	AJV8 SC 4.0L Supercharged

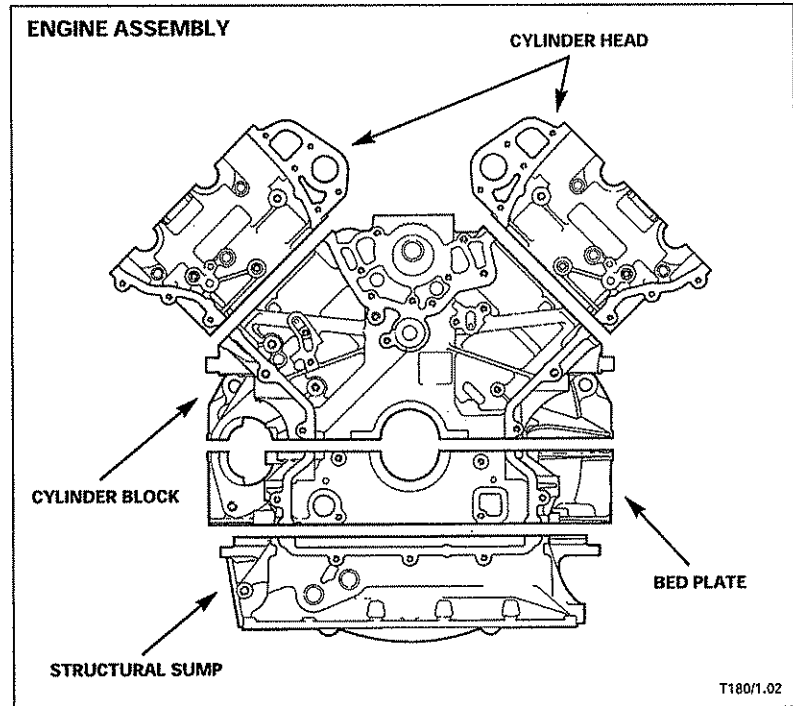
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Cylinder Block Assembly

Cylinder block

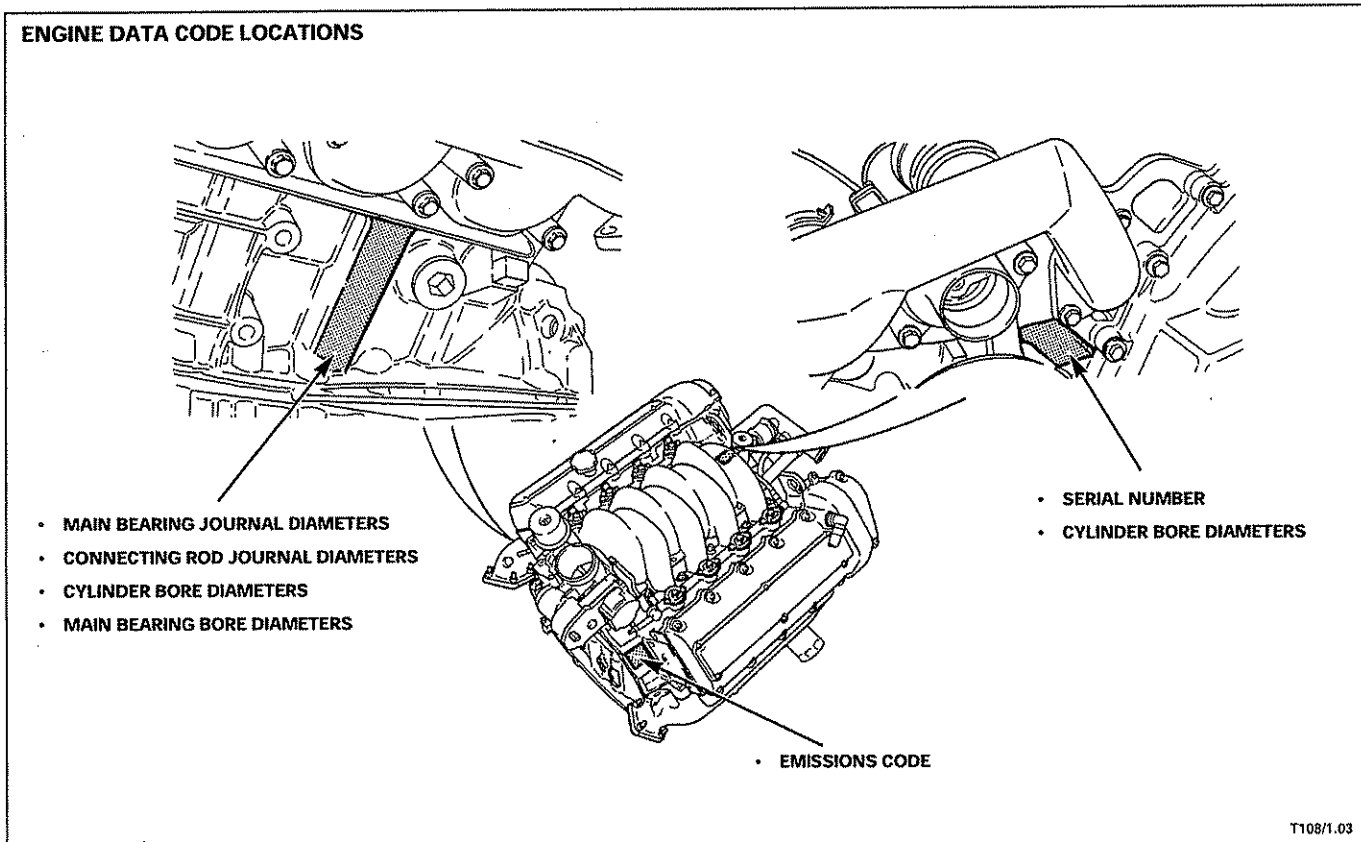
The cylinder block is an "enclosed V" design that provides a rigid engine structure and reduces vibration levels. Nikasil (a composition of nickel and silicon) coated cylinder bores provide excellent friction, heat transfer and wear characteristics. A low volume coolant jacket improves warm-up times and piston noise transfer. The longitudinal coolant flow design, with a single cylinder head coolant transfer port in each bank, improves rigidity and head gasket sealing.

The right side cylinder bank is designated as "A" bank, and the left side as "B" bank. The cylinder bores of each bank are numbered from 1 to 4, starting from the front.



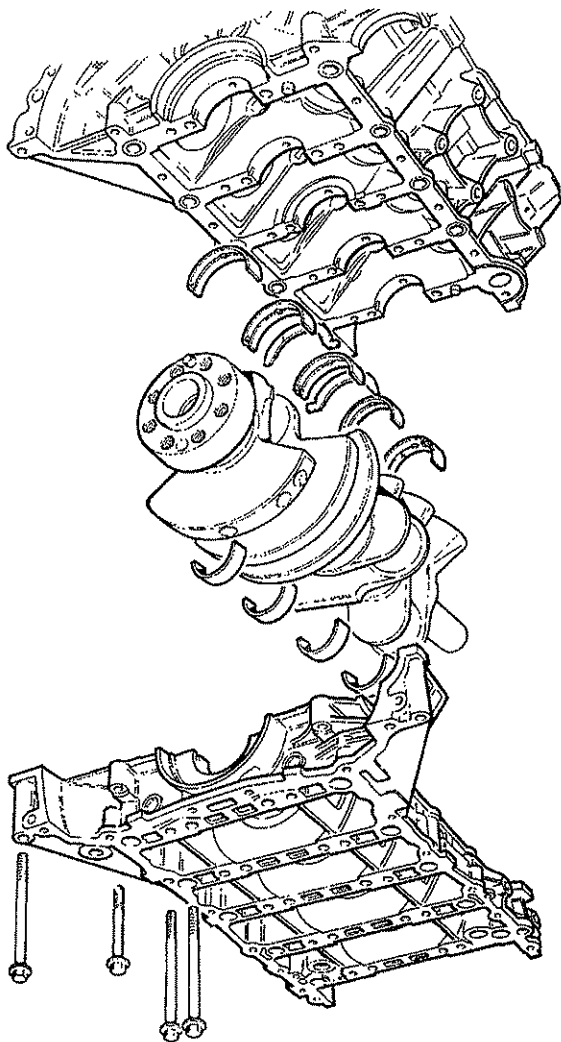
Engine data

Engine data is marked at three locations on the cylinder block. Component dimensions are represented by alphabetical and numerical codes. Refer to page 7 of the Engine Assembly section for code descriptions.



Cylinder Block Assembly (continued)

CYLINDER BLOCK, CRANKSHAFT AND BED PLATE



T180/1.04

Bed plate

The bed plate is a structural casting bolted to the bottom of the cylinder block to retain the crankshaft. The use of a bed plate further improves rigidity. Iron inserts cast into the bed plate main bearing supports minimize main bearing clearance changes due to heat expansion.

Two hollow dowels align the bed plate with the cylinder block.

The bed plate to cylinder block joint is sealed with Loctite Ultra Gray 5699 RTV.

Crankshaft

Manufactured in nodular cast iron, the five main bearing crankshaft has six counterbalance weights to ensure smooth rotation. The five main bearing and four connecting rod journals have undercut and rolled fillets for improved strength. The crankshaft is not hardened and should be handled carefully to prevent damage to the bearing surfaces. It should not be reground. Regrinding will damage the rolled fillets and weaken the crankshaft.

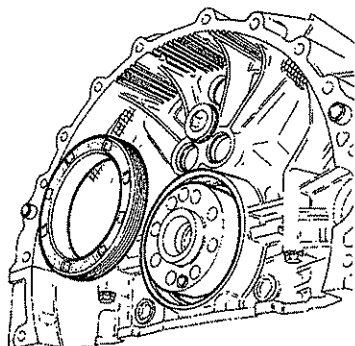
The main bearings are aluminum / tin split plain bearings. An oil groove in the top half of each bearing transfers oil into the crankshaft for lubrication of the connecting rod bearings. A lead / bronze thrust washer is installed on each side of the top half of the center main bearing.

Crankshaft rear oil seal

The crankshaft rear oil seal (a lip seal similar to that used on the AJ16 engine) is a press fit in the bedplate to cylinder block interface.

NOTES

CRANKSHAFT REAR OIL SEAL



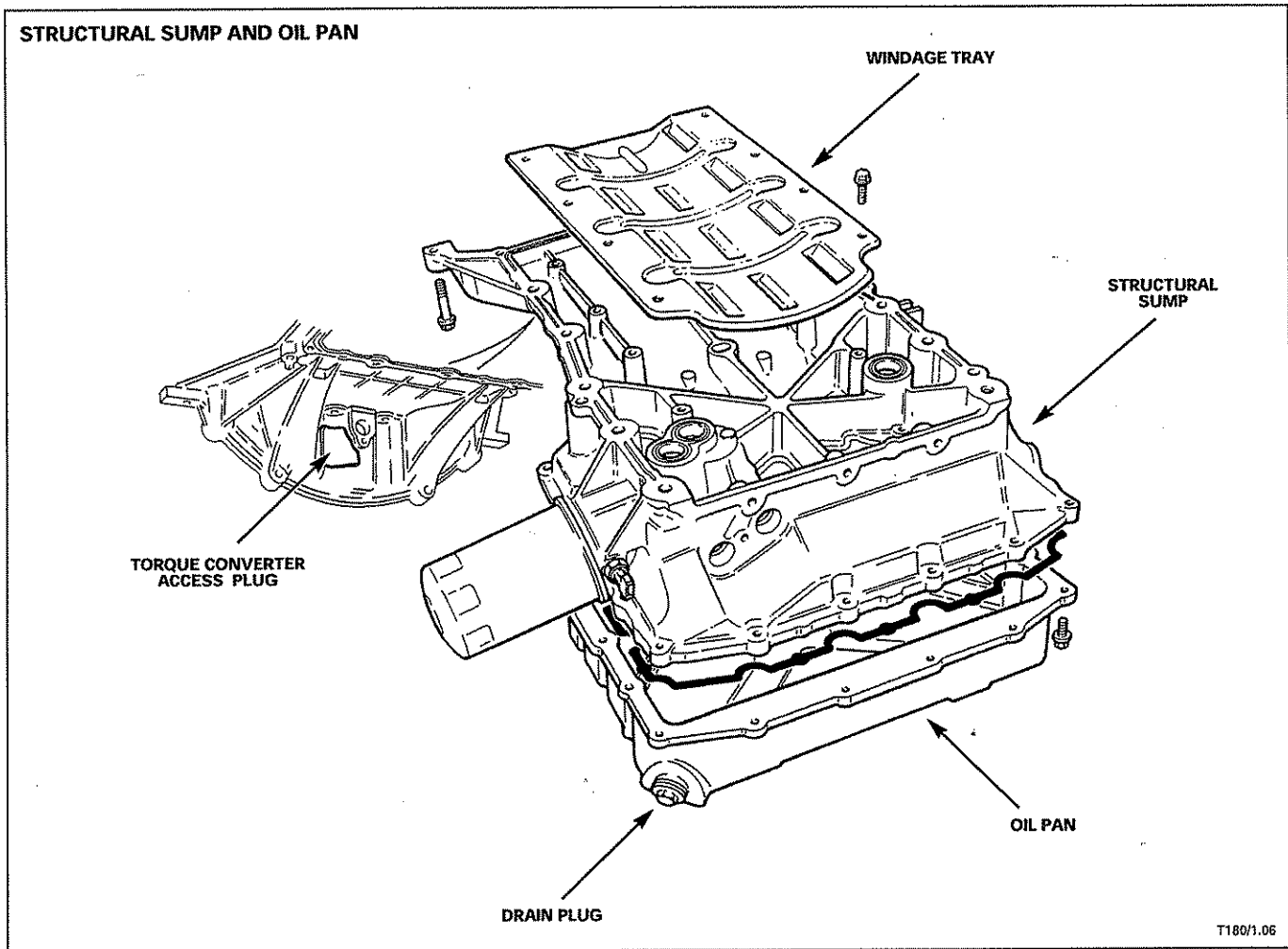
T180/1.05

Structural sump

The aluminum alloy structural sump bolts to the bed plate and a pressed steel oil pan bolts to the structural sump. A windage tray attached to the top of the structural sump prevents oil aeration caused by crankshaft rotation and improves oil drainage. A rubber plug at the rear of the structural sump provides access to the torque converter securing bolts. The engine oil drain plug is located at the front right corner of the oil pan.

NOTE: The drain plug washer must not be reused.

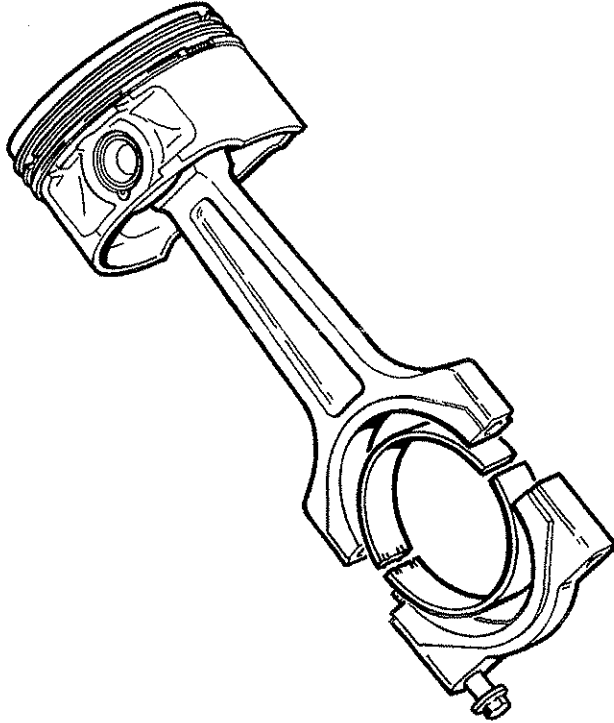
The structural sump to bed plate joint is sealed with Loctite Ultra Gray 5699 RTV. A silicon rubber in-groove gasket is used between the oil pan and the structural sump.



NOTES

Connecting Rods and Pistons

CONNECTING RODS AND PISTON



T180/1.07

Connecting rods

The connecting rods are manufactured of sinter forged steel. The precision manufacturing process requires no balancing and little machining. The bearing caps are produced by fracturing the opposing sides of the connecting rod at the bearing horizontal center-line. When reassembled, the fractured surfaces interlock to form a strong seamless joint. The cylinder position is etched on adjoining sides of the joint to identify matching connecting rods and bearing caps. The connecting rod bearings are lead / bronze split plain bearings. The wrist pin bushings are lead / bronze.

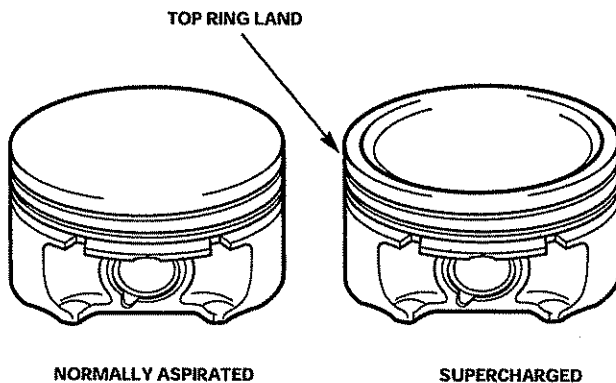
Pistons

The pistons are designed with short skirts to reduce friction and offset full floating wrist pins to reduce noise. Three piston rings, two compression and one oil control, are installed on each piston.

Supercharged pistons are dished to reduce the compression ratio from 10.75 : 1 to 9.00 : 1. The top piston ring land is also thicker to resist the additional thermal and mechanical loads produced by supercharging.

NOTES

PISTONS



T180/1.08

Starter and Drive Plate

Starter motor

The engine starter motor is located at the rear left side of the engine, bolted to the cylinder block and the bed plate.

Torque converter drive plate

The ring gear is attached to the torque converter drive plate. A timing disc for the crankshaft position sensor (CKPS) is spot welded to the front face of the drive plate.

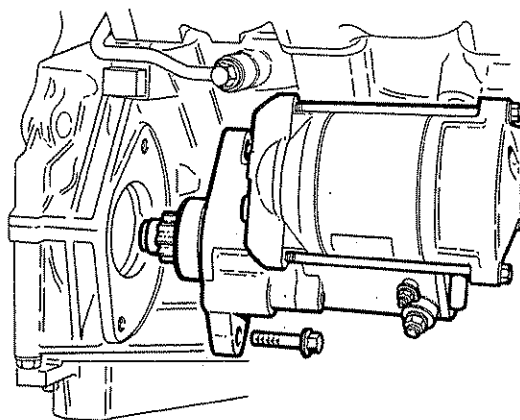
Timing disc

The timing disc contains one elongated slot designed to accept the camshaft timing tool JD 216. The tool is used to align the crankshaft at 45° ATDC when timing the camshafts.

⚠ CAUTION: Do not rotate the crankshaft while tool JD 216 is installed. The drive plate and timing disc will be damaged.

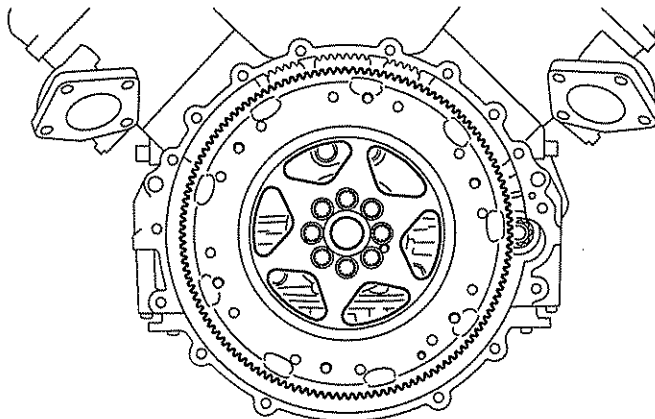
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STARTER MOTOR



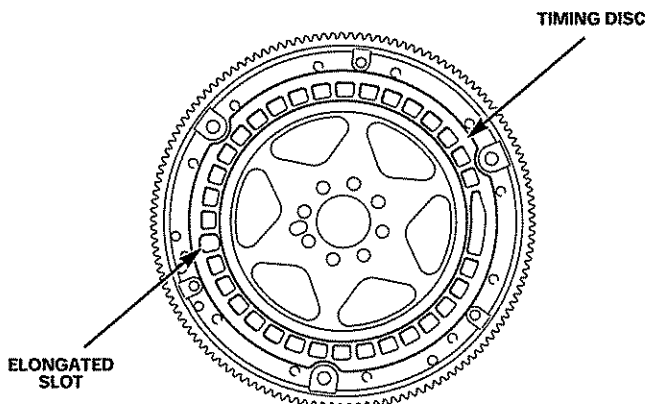
T108/1.09

DRIVE PLATE AND RING GEAR



T180/1.10

CYLINDER BLOCK SIDE OF DRIVE PLATE AND TIMING DISC



T180/1.11

AJV8 Engine Overview

Cylinder Heads

The aluminum alloy cylinder heads are unique to each cylinder bank. They are cast using a process that precisely controls combustion chamber volumes and coolant passages. Deep seated head bolts reduce distortion and provide stable gasket clamping forces. Two hollow dowels align each cylinder head with the cylinder block.

The cylinder head gaskets consist of a silicon beaded composite gasket with metal eyelets for the cylinder bores. The normally aspirated head gasket eyelets are mild steel; the supercharged eyelets are stainless steel.

Each cylinder head incorporates dual overhead camshafts operating four valves per cylinder via aluminum alloy valve lifters. Steel shims in the top of the valve lifters enable valve clearance adjustment.

The lightweight valve gear provides good economy and noise levels. Valve head diameters are 31 mm for the exhaust and 35 mm for the intake. All valves have 5 mm diameter stems supported in sintered metal valve guides. Valve spring collars, keepers and spring seats locate single valve springs for both intake and exhaust valves. Valve stem seals are integrated into the spring seats.

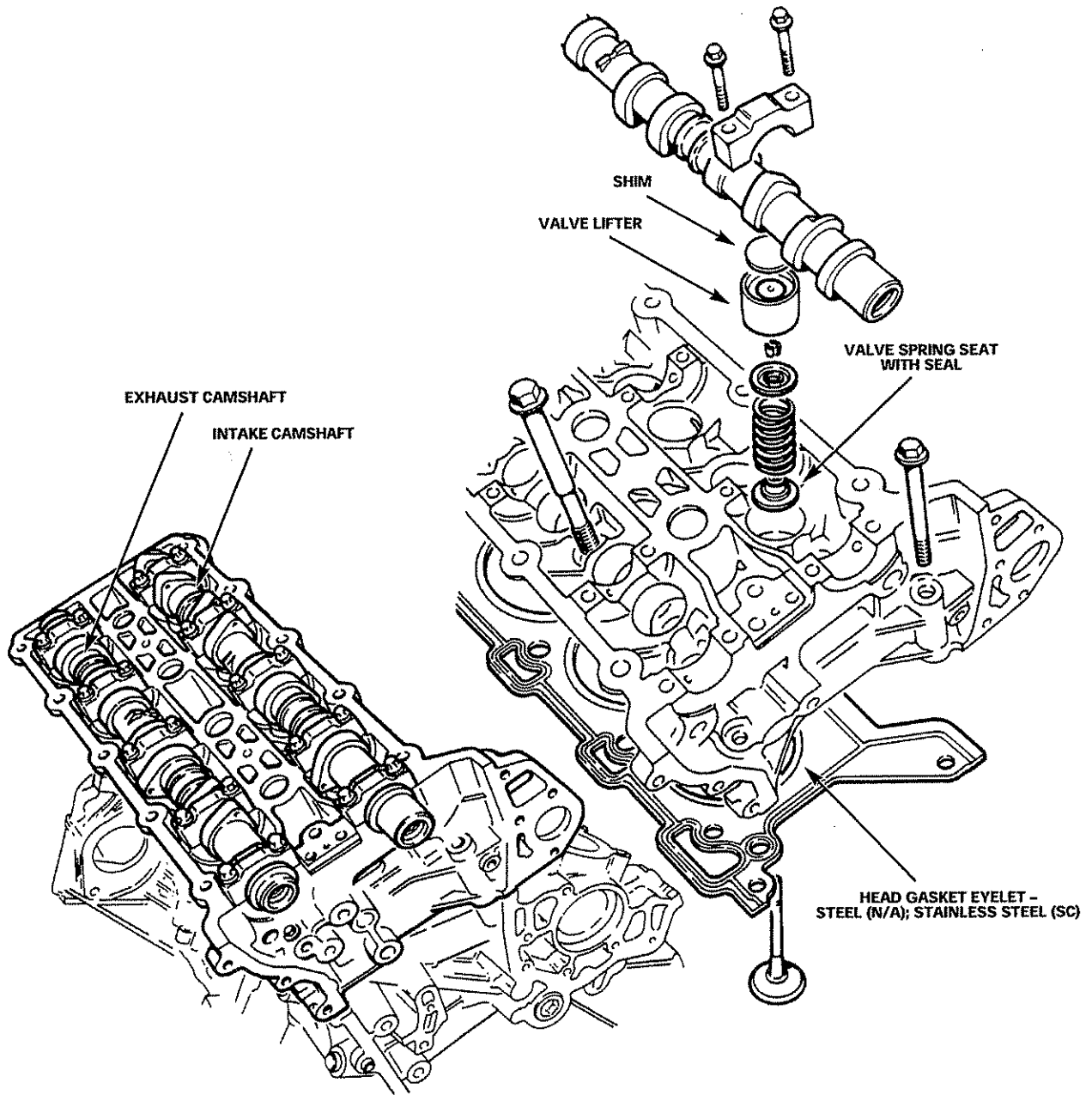
The camshafts are manufactured in chilled cast iron and center drilled to reduce weight. Five aluminum alloy caps retain each camshaft. The caps are numbered for location: 0 to 4 for the intake camshaft and 5 to 9 for the exhaust camshaft. The rear of the 'B' bank intake camshaft has a timing ring for the camshaft position sensor (CMPS). A flat is machined near the front of each camshaft to lock the camshafts during valve timing.

14 mm spark plugs, one per cylinder, locate in recesses down the center-line of each cylinder head.

An engine lifting eye is cast into the front of each cylinder head (the rear lifting eyes, one on each cylinder head, are bolt-on tools).

NOTES

'A' BANK CYLINDER HEAD



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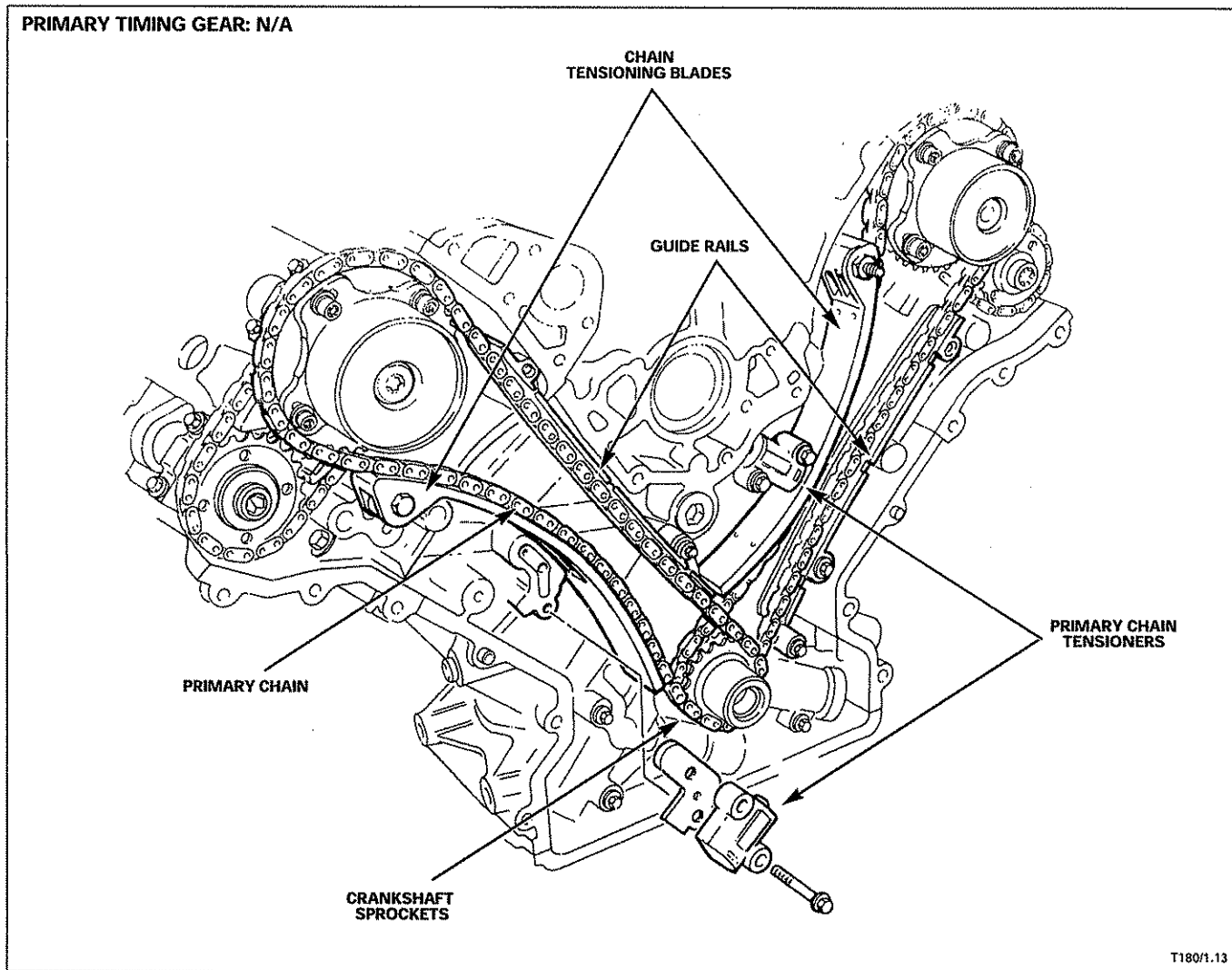
AJV8 Engine Overview

Timing Gear

Primary Timing Gear

Single row primary and secondary chains drive the camshafts of each cylinder bank. The primary chains transmit the drive from two crankshaft sprockets to the intake camshaft variable valve timing (VVT) units (supercharged engines do not use VVT units). Secondary chains transmit the drive from the intake camshaft sprockets to sprockets on the exhaust camshafts.

A key locates the two drive sprockets on the crankshaft. The crankshaft vibration damper retains the sprockets in position.



NOTES

Secondary Timing Gear and Chain Tensioners

Normally aspirated (N/A)

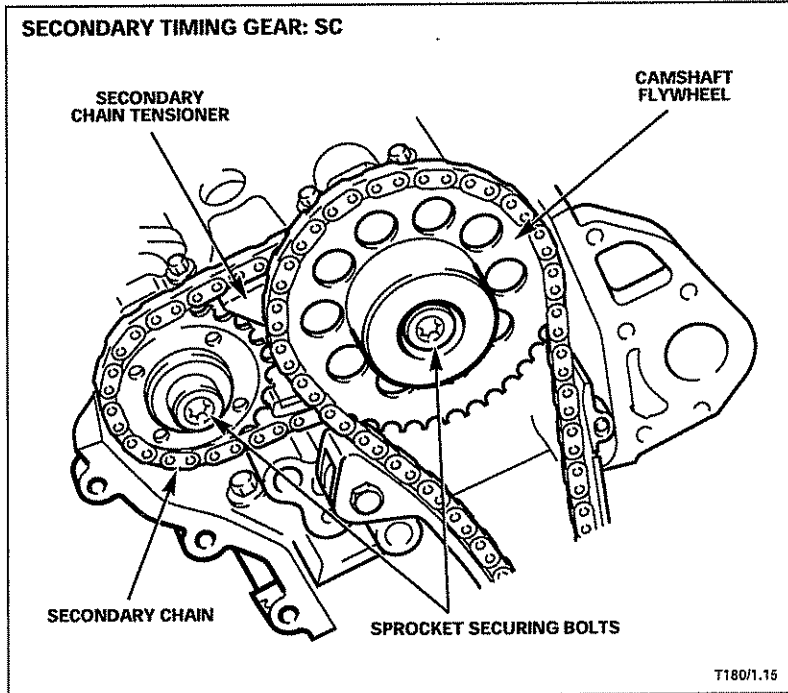
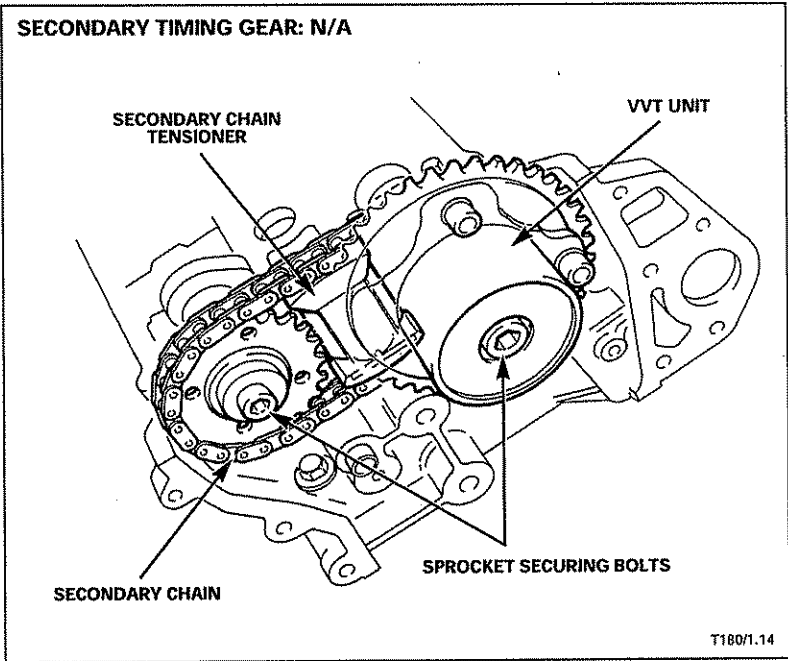
The variable valve timing units and the exhaust camshaft sprockets drive the camshafts via the face to face friction load produced by the valve timing unit / sprocket securing bolts.

Each chain has a hydraulic tensioner operated by engine oil pressure. A jet of oil from the end of each tensioner lubricates the chains. The primary chain tensioners act on pivoting flexible tensioner blades. The secondary chain tensioners act directly on the chains. Guide rails are installed on the drive side of the primary chains.

Supercharged (SC)

Supercharged engine timing gear is the same as normally aspirated versions with the exception of the variable valve timing mechanism and associated components. A flywheel is used on the intake camshaft sprockets to dampen camshaft and chain oscillations.

NOTES

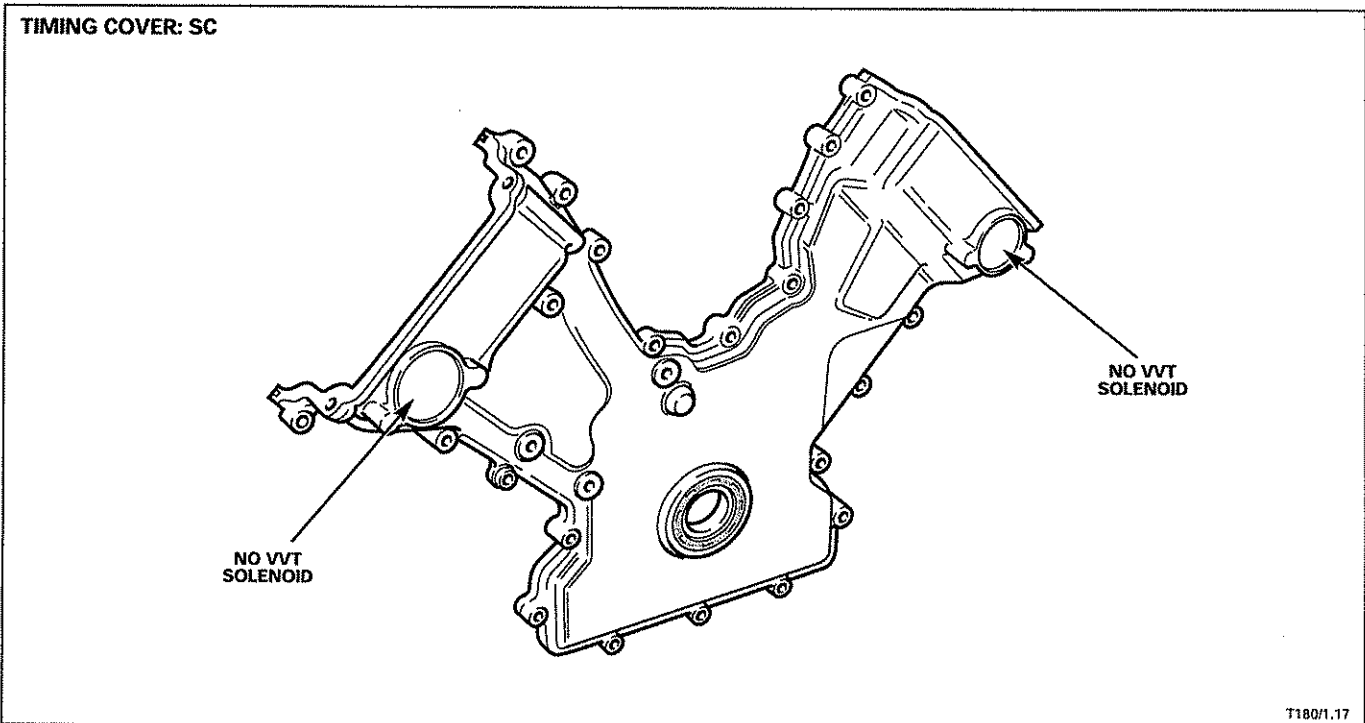
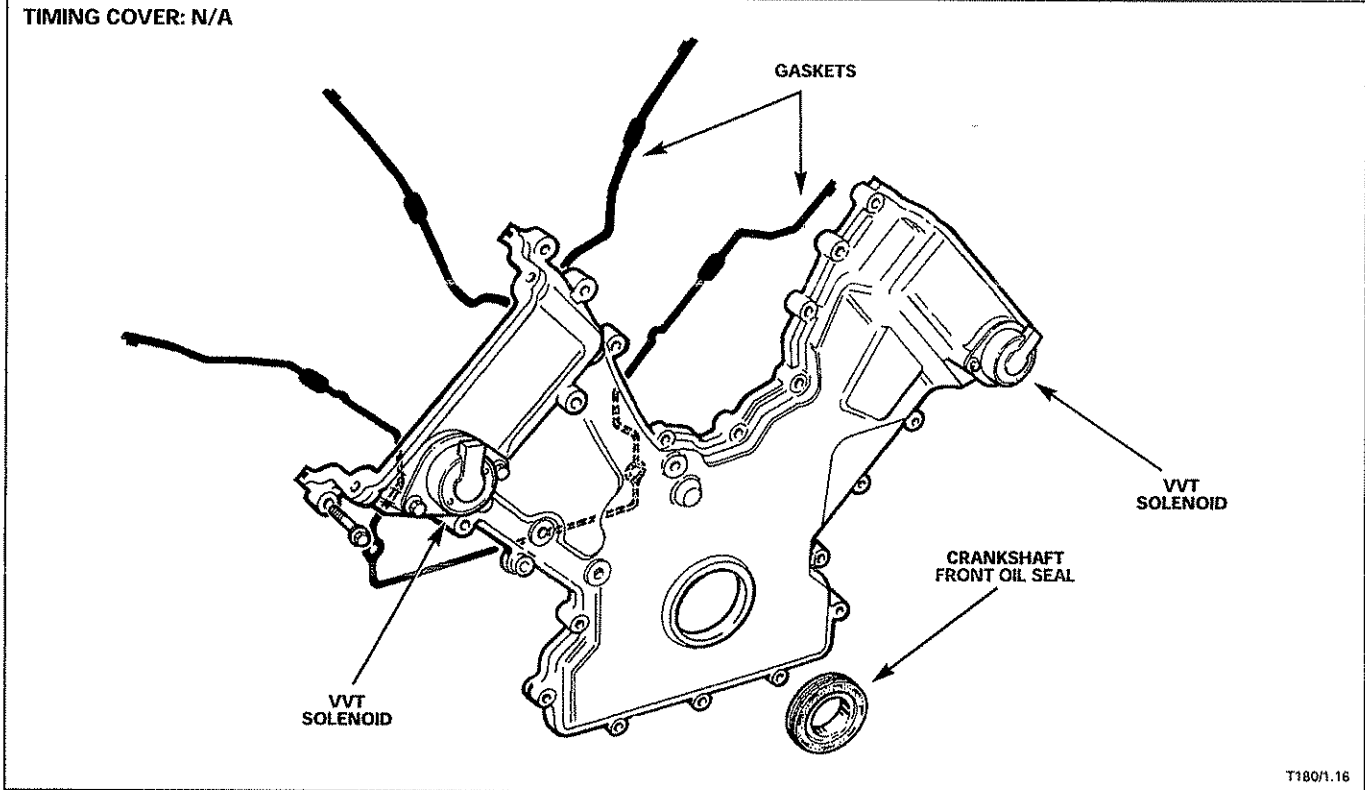


AJV8 Engine Overview

Timing Gear (continued)

Timing cover

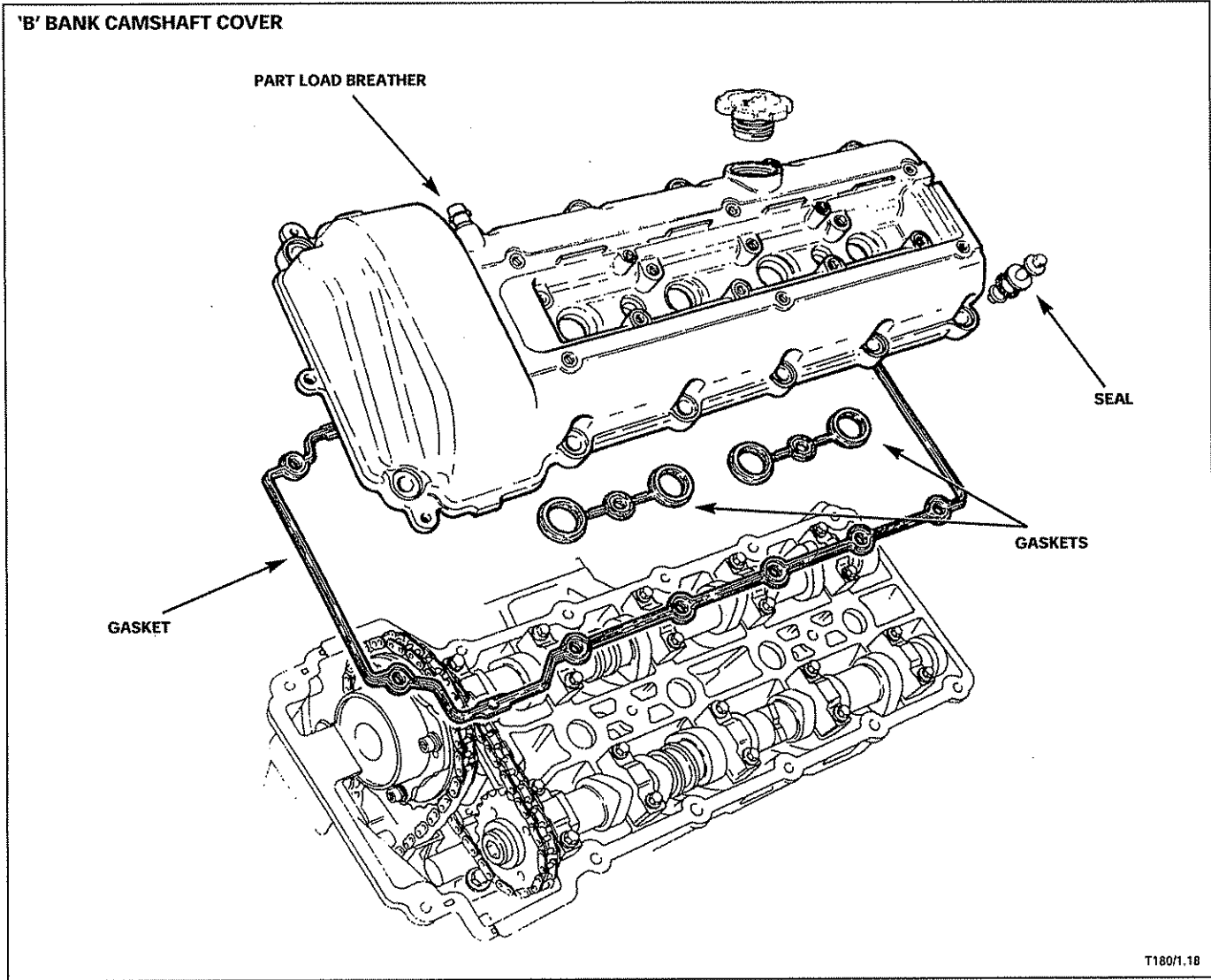
The aluminum alloy timing cover accommodates the crankshaft front oil seal (a PTFE lip seal) and the two variable valve timing solenoids. Silicon rubber in-groove gaskets seal the joint between the timing cover and the front face of the engine.



Camshaft Covers

The camshaft covers are manufactured from vinyl ester plastic. The 'A' bank camshaft cover incorporates an outlet for the full load engine breather. The 'B' bank camshaft cover incorporates the engine oil filler cap and an outlet for the part load engine breather. Identical oil separators are incorporated below the breather outlet in each cover.

Silicon rubber in-groove gaskets seal the camshaft cover to cylinder head joints. The gaskets and the spacers and seals on the camshaft cover fasteners isolate the covers from direct contact with the cylinder heads to reduce noise.



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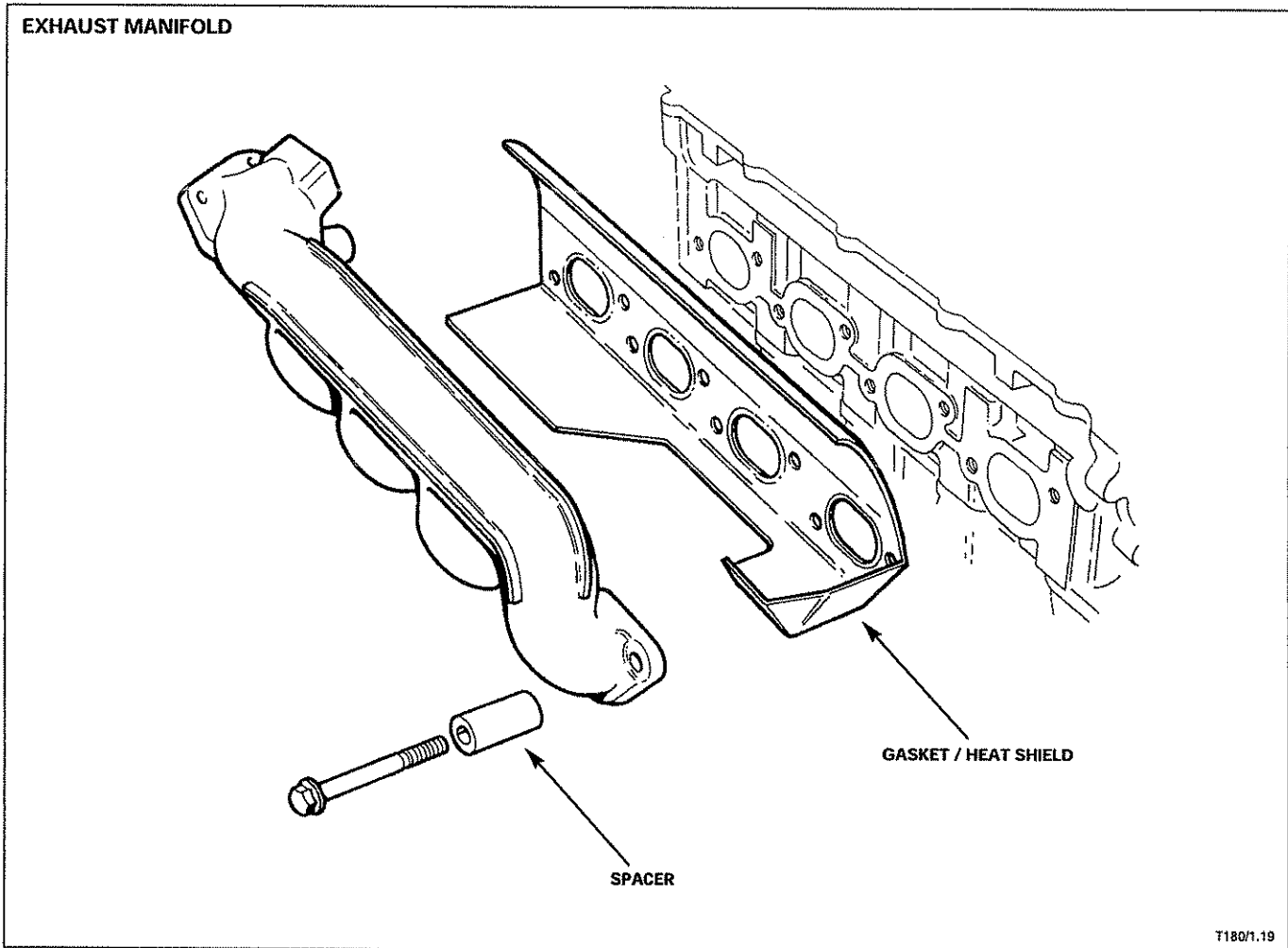
AJV8 Engine Overview

Exhaust Manifolds

The thin-wall cast iron manifolds are unique for each cylinder bank. On engines with EGR, the 'A' bank manifold has a connection for the transfer pipe.

Spacers on the securing bolts allow the bolts to maintain optimum gasket clamping loads as the components expand and contract with temperature changes.

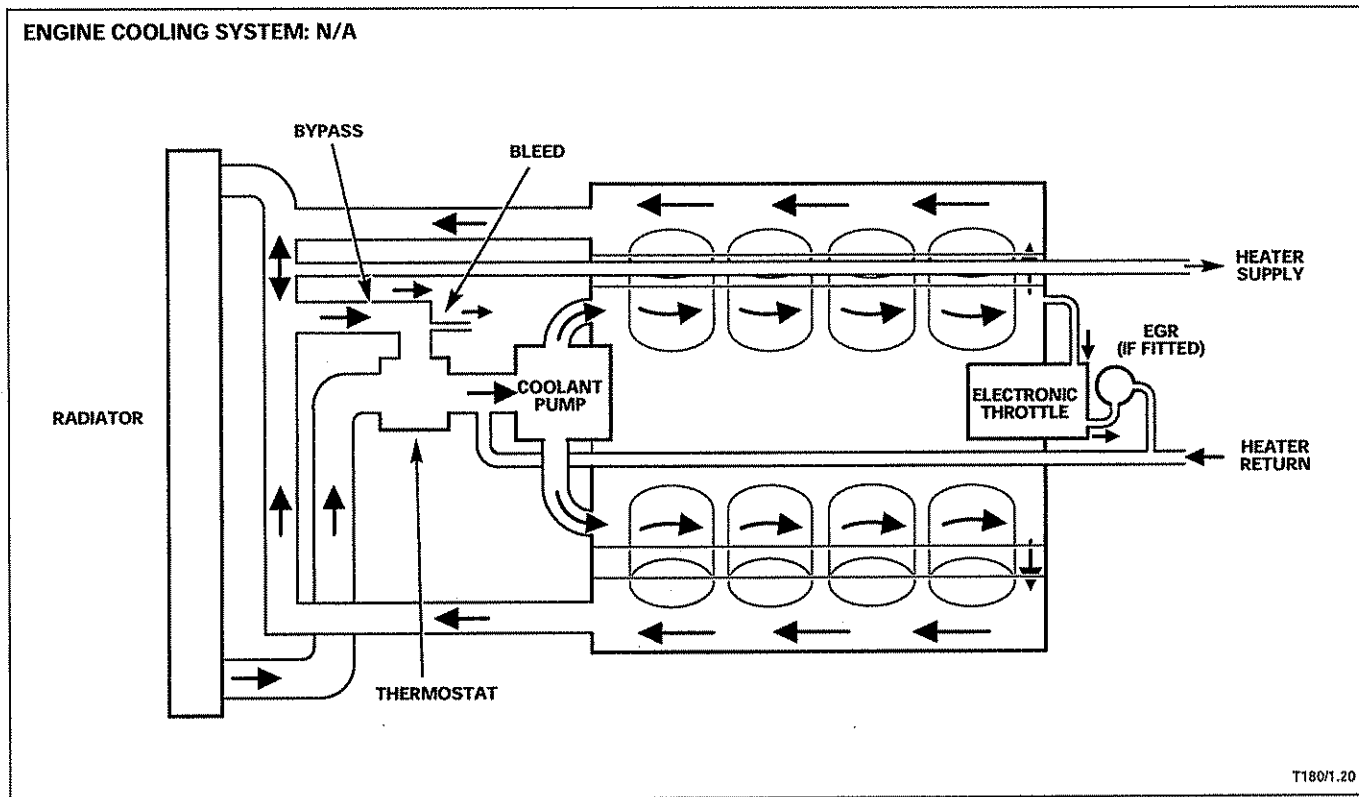
Heat shields are integrated into the exhaust manifold gaskets.



NOTES

Engine Cooling System

The cooling system is a low volume, high velocity system with good warm-up and temperature profile characteristics.



From the pump, the coolant flows into each bank of the cylinder block. In each bank, 50% of the coolant cools the cylinder bores and 50% is diverted through a bypass gallery. At the rear of the banks the two flows mix and enter the cylinder heads. The coolant then flows forward to the outlet ports, cooling the cylinder heads. When the thermostat is closed, the coolant returns directly to the pump through the bypass on the thermostat housing and recirculates through the engine. When the thermostat is open, the coolant flows through the radiator before returning to the pump. Cylinder block coolant also flows from a pipe attached to the block behind the starter motor to the electronic throttle assembly and EGR valve (if fitted). The coolant returns to the pump by joining the heater return flow.

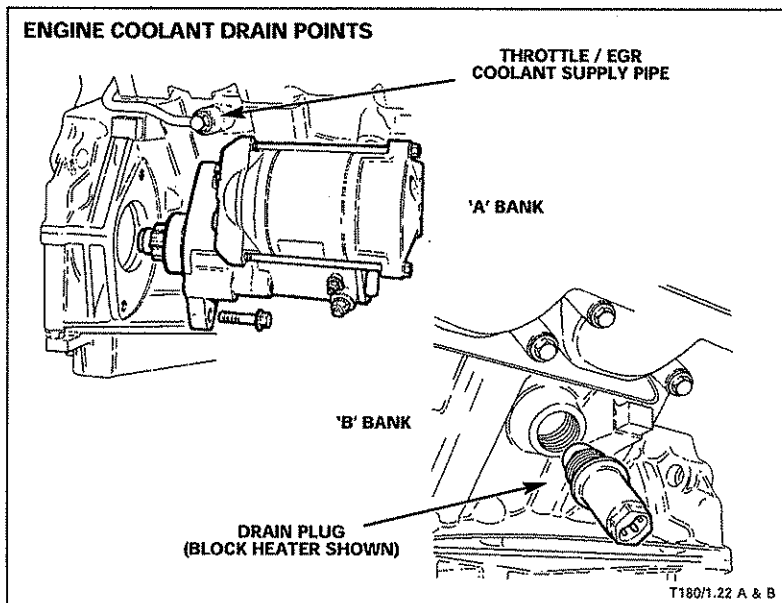
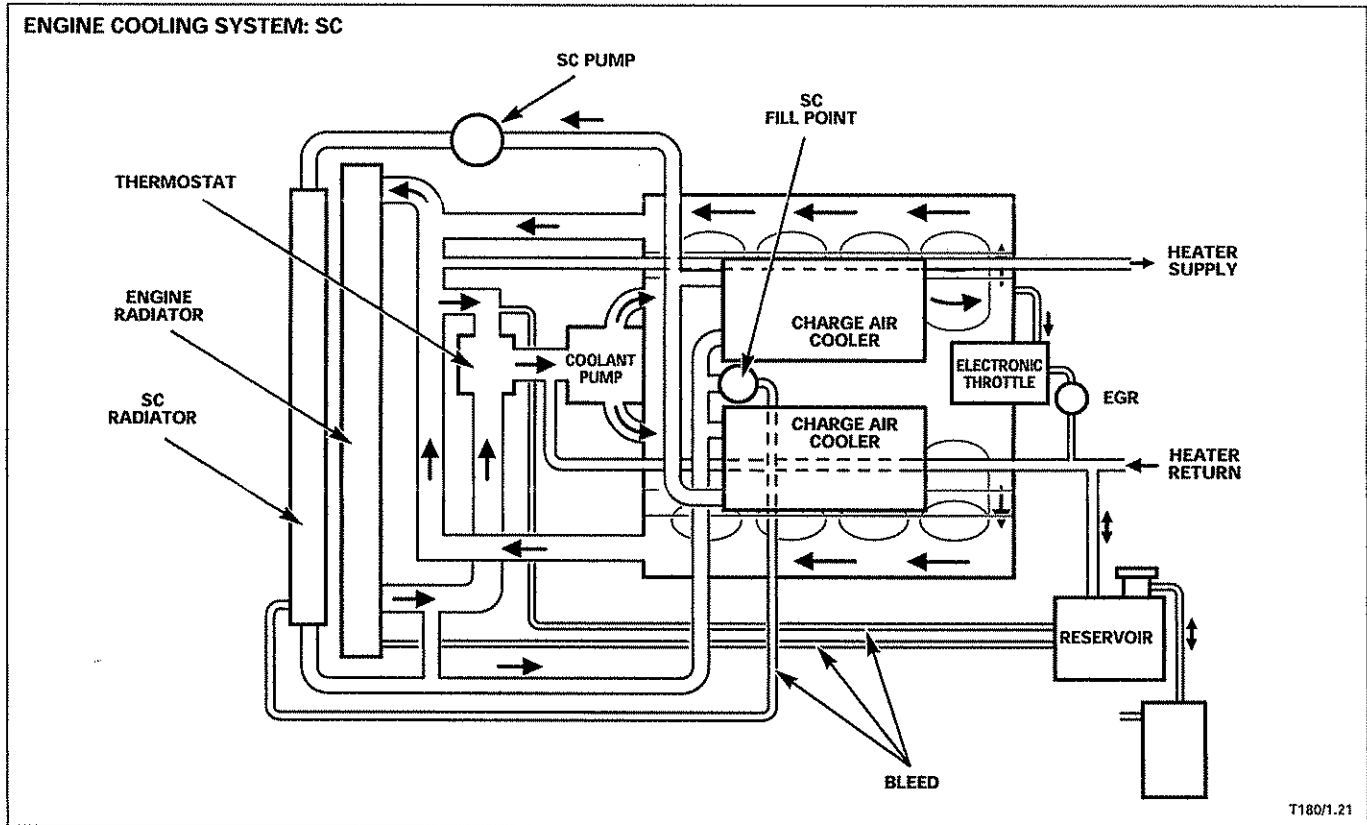
NOTES

AJV8 Engine Overview

Engine Cooling System (continued)

The SC engine cooling system is similar to the N/A system. A separate radiator and cooling system is added for the supercharger charge air coolers. The charge air cooler system incorporates an electrically operated pump to circulate coolant. A bleed line from the supercharger radiator and filler point prevents air being trapped in the system.

The SC cooling system is connected to the engine cooling system to allow the two systems to share coolant from the common reservoir.



Engine coolant drain points

Coolant is drained from the 'A' bank by removing the throttle / EGR coolant supply pipe behind the starter motor.

Coolant is drained from the 'B' bank by a drain plug is installed on the rear left side of the cylinder block. On vehicles with the cold climate package, a cylinder block heater replaces the drain plug.

NOTES

Coolant pump

The coolant pump is installed on the front face of the cylinder block between the two cylinder banks. The pumping element is a shrouded plastic impeller. Coolant escapes from seal breather holes in the housing if the pump bearing seal fails.

An 'O' ring and an edge bonded rubber / aluminum alloy gasket seal the pump to cylinder block interface. The 'O' ring seals the inlet port from the thermostat. The gasket seals the outlet ports into the cylinder banks.

Thermostat housing

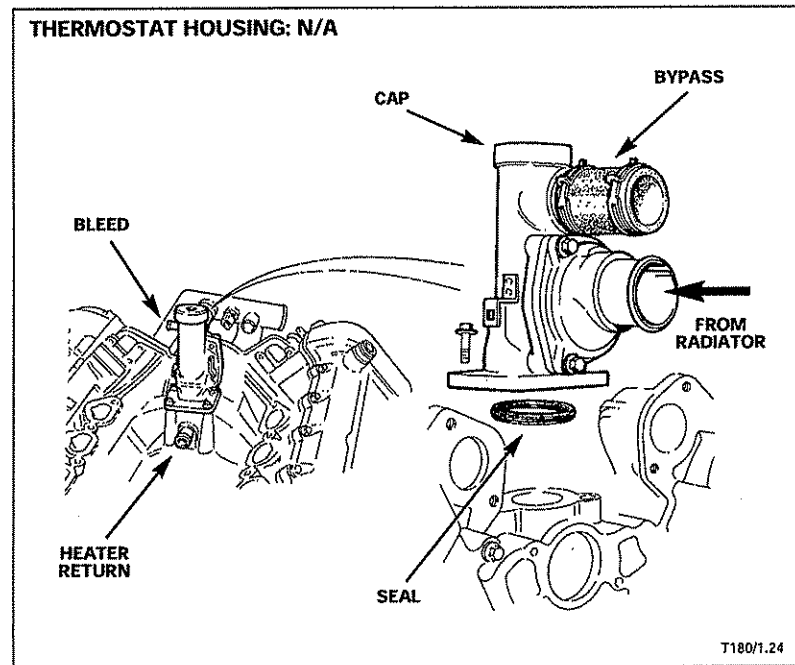
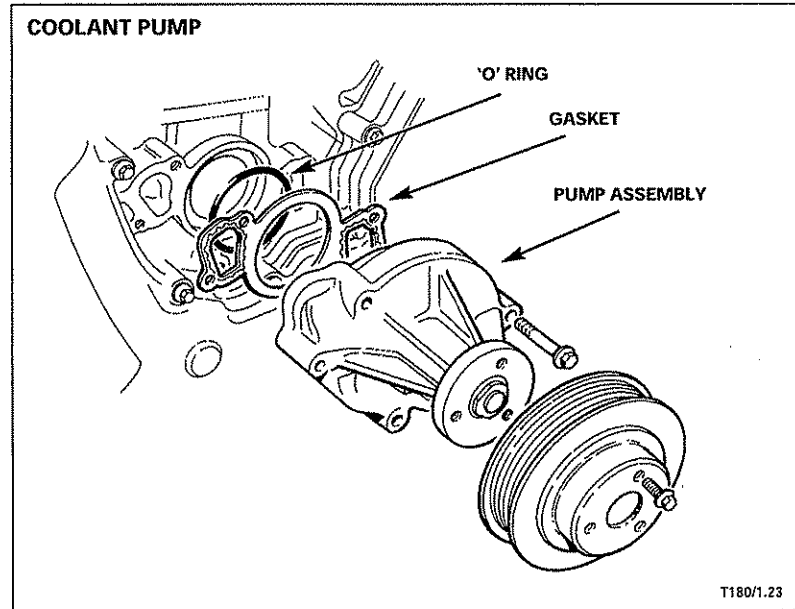
The composite N/A thermostat housing is installed between the two cylinder banks above the coolant pump. The aluminum alloy SC thermostat housing is combined with the coolant outlet duct. Refer to page 21. On both systems the thermostat starts to open at 80 – 84 °C (176 – 183 °F) and is fully open at 96 °C (205 °F).

A duct in the cylinder block connects the thermostat housing outlet to the pump inlet. A stub pipe connects the duct to the air conditioning heater matrix return line. An in-groove gasket seals the joint between the thermostat housing and the cylinder block.

In addition to containing the thermostat, the plastic thermostat housing incorporates connections for the bleed, bypass and radiator bottom hoses. The bleed outlet vents any air in the system into the vehicle's coolant reservoir.

The cap of the thermostat housing is removable to allow air out of the system when filling from empty.

⚠ CAUTION: Use the correct torque (marked on the cap) when reinstalling the cap, or the cap / thermostat housing could be damaged.



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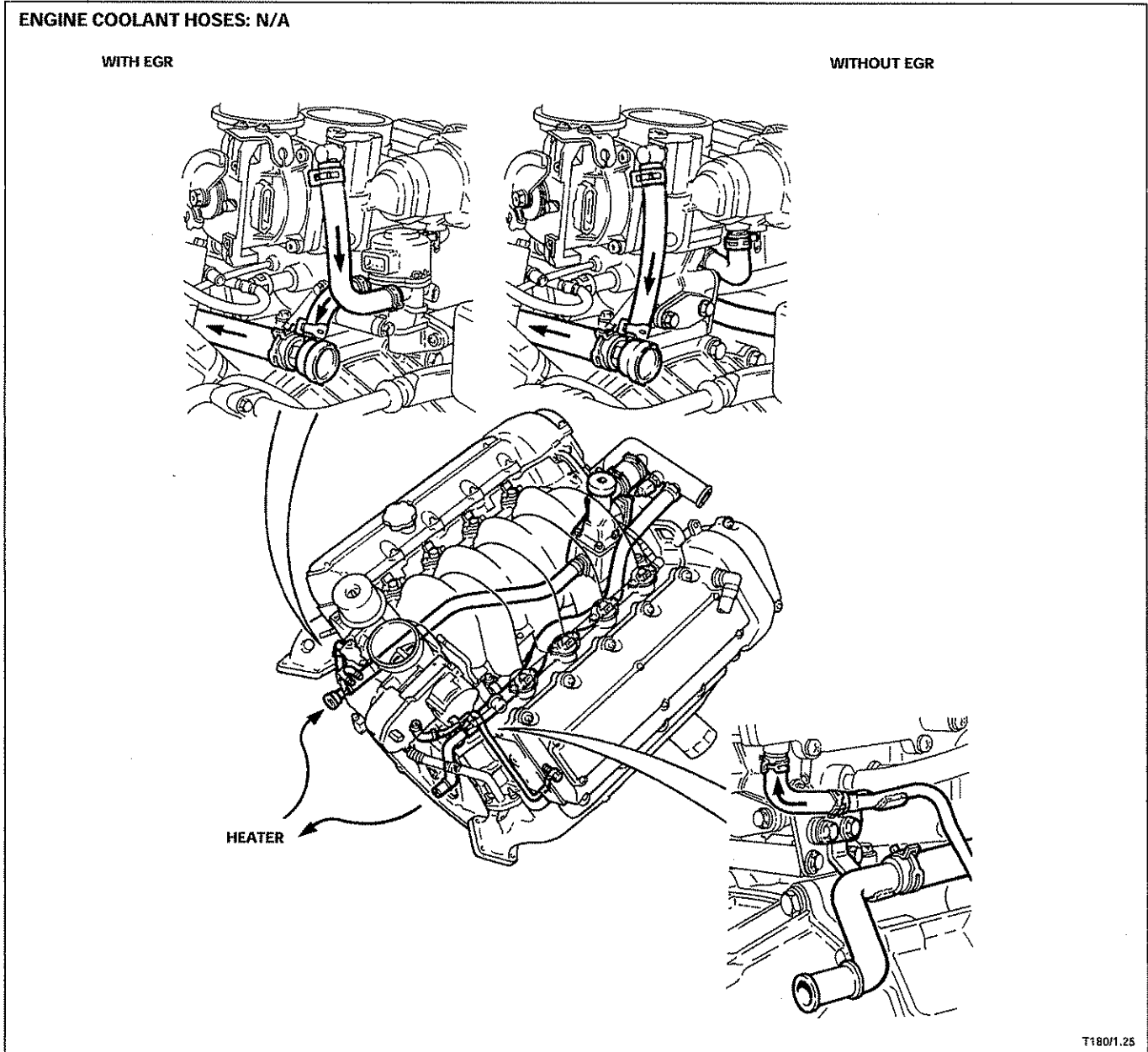
AJV8 Engine Overview

Engine Cooling System (continued)

Coolant hoses

Supply and return hoses for the air conditioning heater matrix are installed between the cylinder banks.

A connection at the rear of 'A' bank provides the coolant supply for the electronic throttle and the EGR valve (where fitted). The outlet from the electronic throttle connects to the return hose of the air conditioning heater matrix.



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Coolant outlet duct: N/A

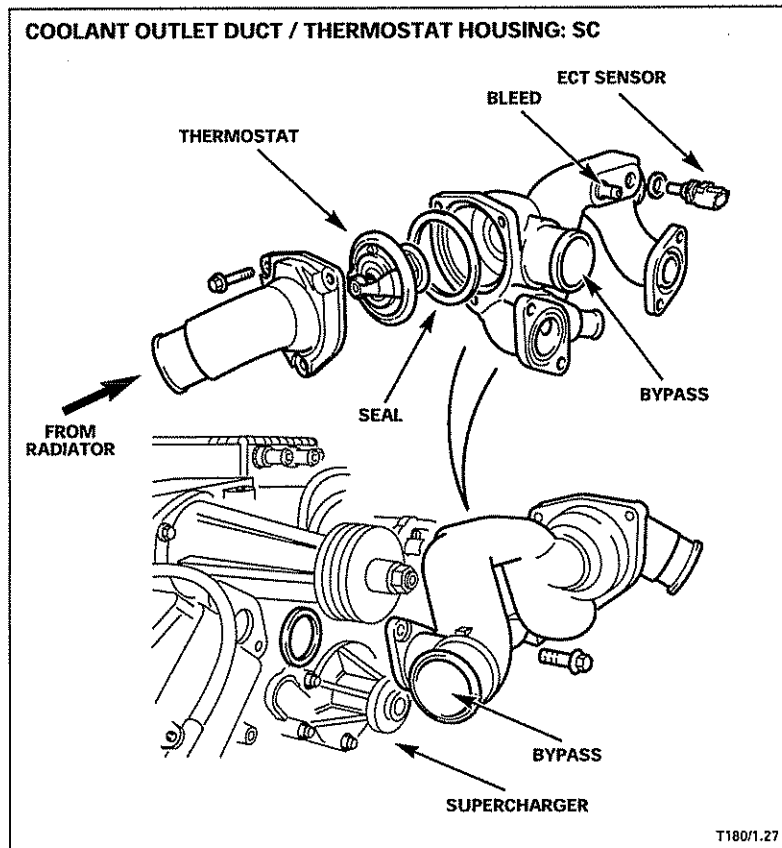
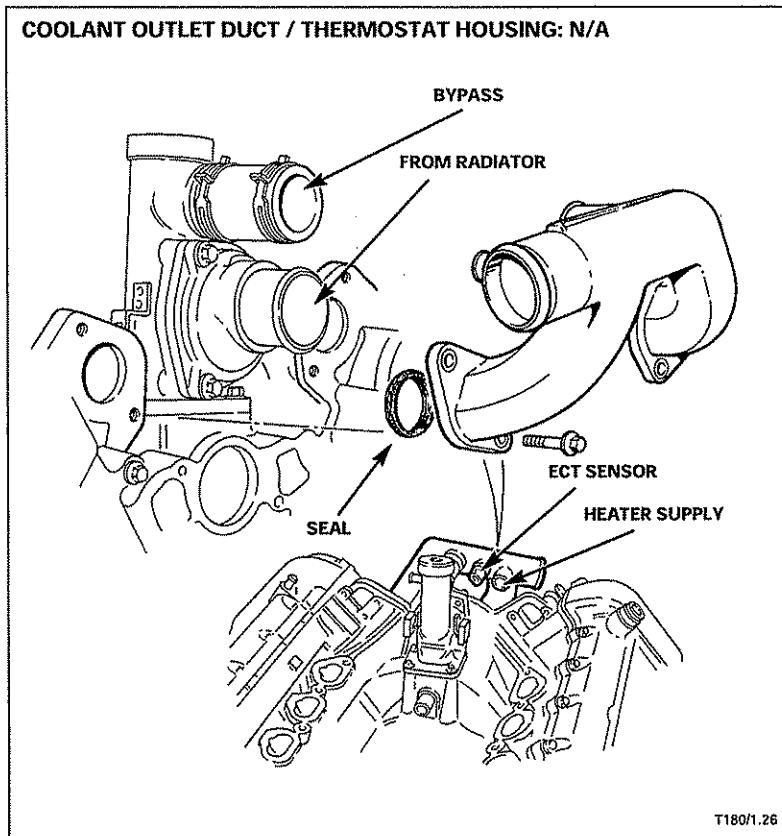
The plastic coolant outlet duct connects to the outlet port of each cylinder head to provide a common connection point for the radiator top hose. It also incorporates connections for the coolant temperature sensor, the supply to the heater matrix and the bypass flow to the thermostat housing.

An in-groove gasket seals each of the joints between the outlet duct and the cylinder heads.

Coolant outlet duct and thermostat housing: SC

The aluminum alloy coolant outlet duct and thermostat housing for supercharged vehicles are combined to allow room for mounting the charge air coolers and supercharger.

NOTES



Engine Lubrication

Oil is drawn from the reservoir in the oil pan and pressurized by the oil pump. The output from the oil pump is then filtered and distributed through internal oil passages. If an oil cooler is fitted, the oil is cooled before entering the filter.

All moving parts are lubricated by pressure or splash oil. Pressurized oil is also provided for operation of the VVT units and the timing chain tensioners.

The oil returns to the oil pan under gravity. Large drain holes through the cylinder heads and cylinder block ensure the quick return of the oil, reducing the volume of oil required and enabling an accurate level check soon after the engine stops.

Oil replenishment is through the oil filler cap on the 'B' bank camshaft cover.

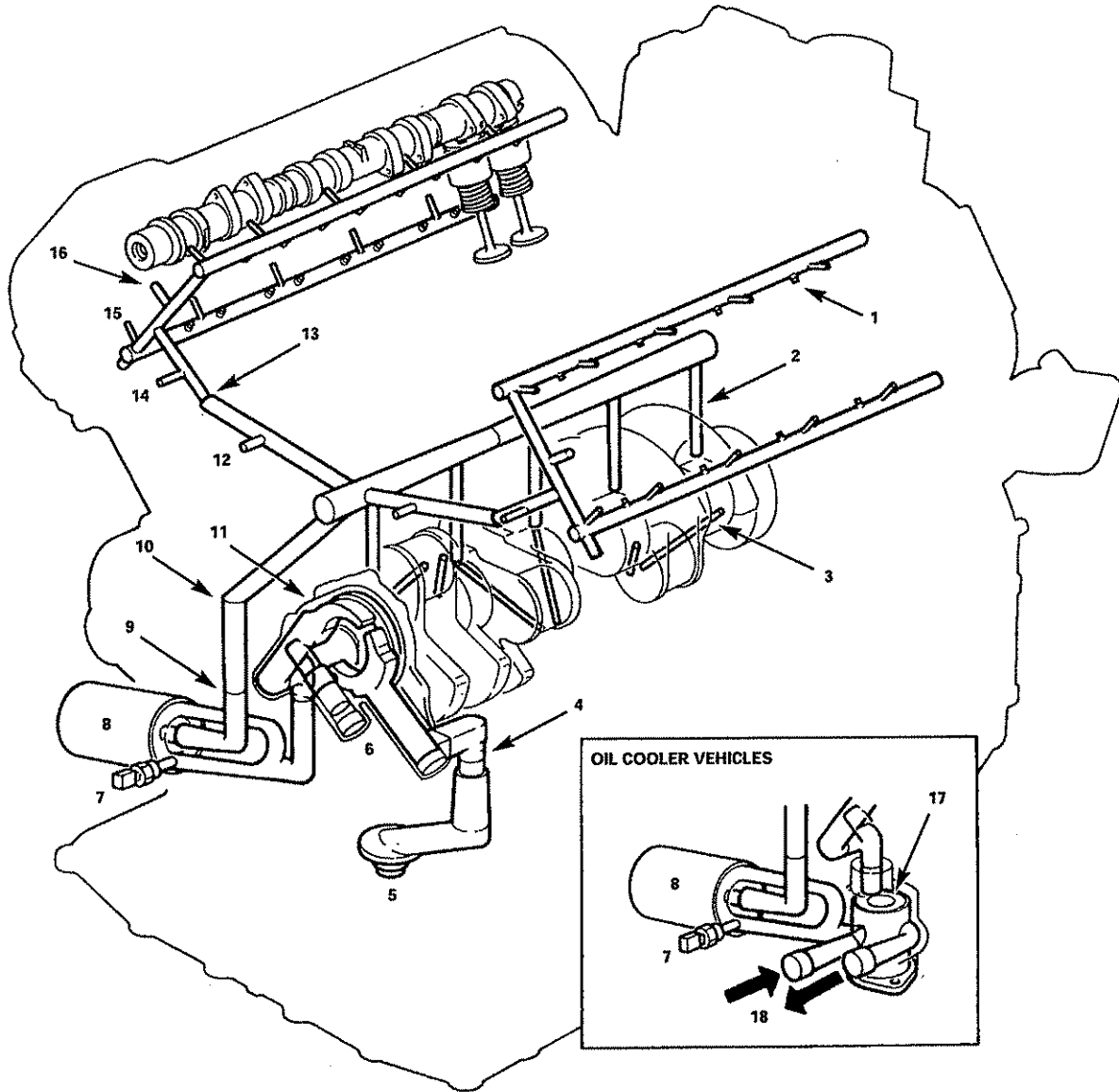
With the exception of the pump and oil level gauge (dip stick), all lubrication system components are installed on the structural sump.

Key to Engine Lubrication System Layout (facing page)

1	Valve lifter supply	10	Bed plate / cylinder block interface
2	Main bearing supply	11	Oil pump
3	Connecting rod bearing supply	12	Primary chain tensioner supply
4	Bed plate / cylinder block interface	13	Cylinder block / cylinder head interface
5	Oil pickup	14	Variable valve timing supply
6	Pressure relief valve	15	Camshaft bearing supply
7	Oil pressure switch	16	Secondary chain tensioner supply
8	Oil filter	17	Oil diverter valve (with oil cooler only)
9	Structural sump / bed plate interface	18	Oil cooler supply and return

NOTES

ENGINE LUBRICATION SYSTEM LAYOUT



T180/1.28

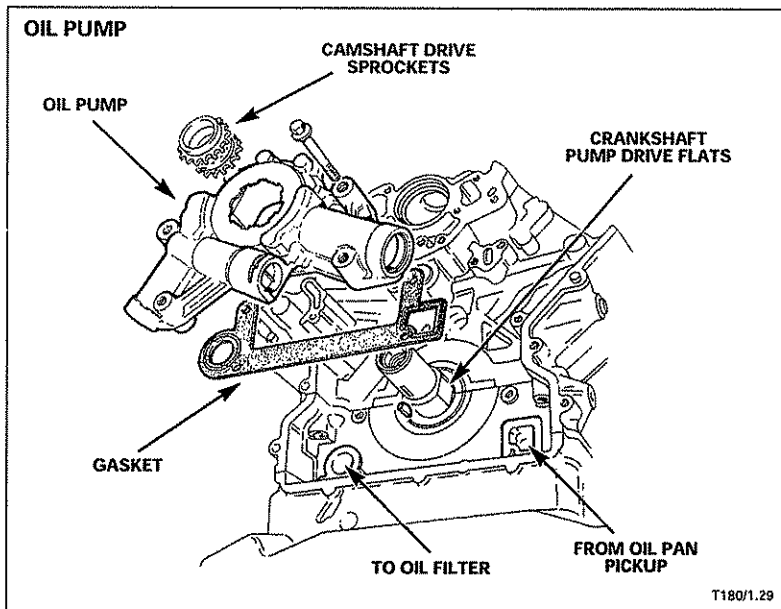
AJV8 Engine Overview

Engine Lubrication (continued)

Oil pump

The oil pump is installed on the crankshaft at the front of the engine. The pump inlet and outlet ports align with oil passages in the bedplate. A rubber coated metal gasket seals the pump to bedplate interface.

The eccentric rotor pump is directly driven by flats on the crankshaft. An integral pressure relief valve regulates maximum pump outlet pressure at 4.5 bar (65 psi).



Oil pickup

The molded oil pickup is immersed in the oil reservoir to provide a supply to the oil pump during all normal vehicle attitudes. The castellated inlet allows the supply to be maintained even if the oil pan is deformed. A mesh screen in the inlet prevents debris from entering the oil system.

Oil filter

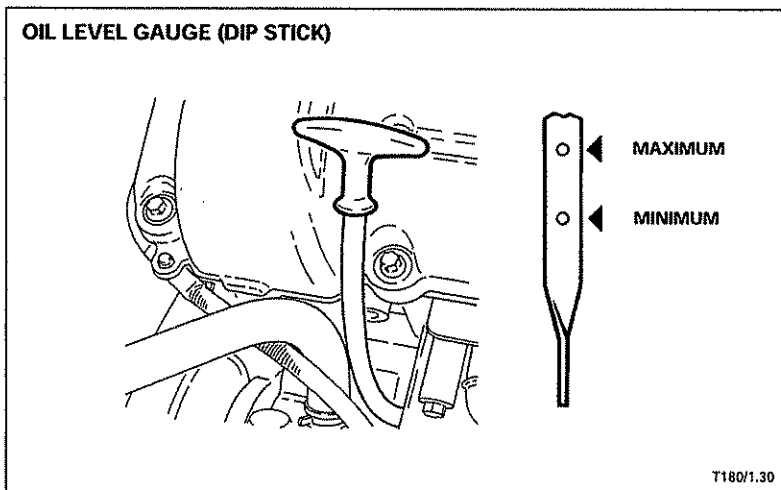
A replaceable canister oil filter installs on an adapter. An internal bypass in the filter permits full flow if the filter element is blocked.

Oil pressure switch

The oil pressure switch connects a ground input to the instrument cluster when oil pressure is present. The switch operates at a pressure of 0.15 to 0.41 bar (2.17 – 5.94 psi).

Oil diverter valve (oil cooler vehicles only)

The oil diverter valve is installed in the passage from the pump outlet to the filter inlet. The thermostatically operated valve diverts the oil through the vehicle mounted oil cooler at higher temperatures. The valve begins to open between 103 and 107 °C (217 – 225 °F), and is fully open, diverting 100% of the oil, at 119 °C (246 °F).

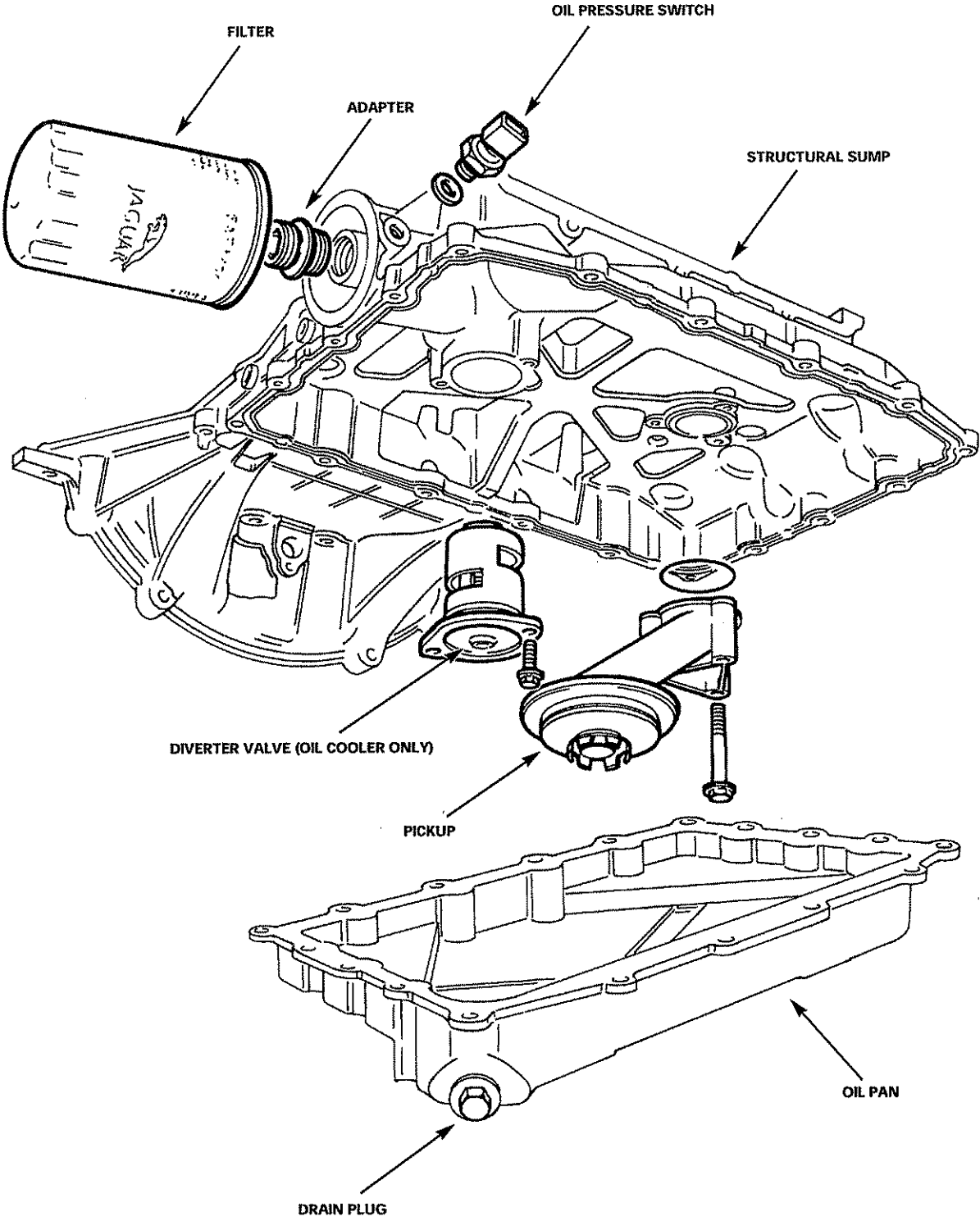


Oil level gauge

The oil level gauge locates midway along the left side of the oil pan, supported in a tube installed in the bedplate. Two holes in the end of the gauge indicate the minimum and maximum oil levels. There is a difference of approximately 1 liter between the two levels.

NOTES

STRUCTURAL SUMP AND OIL PAN LUBRICATION SYSTEM COMPONENTS

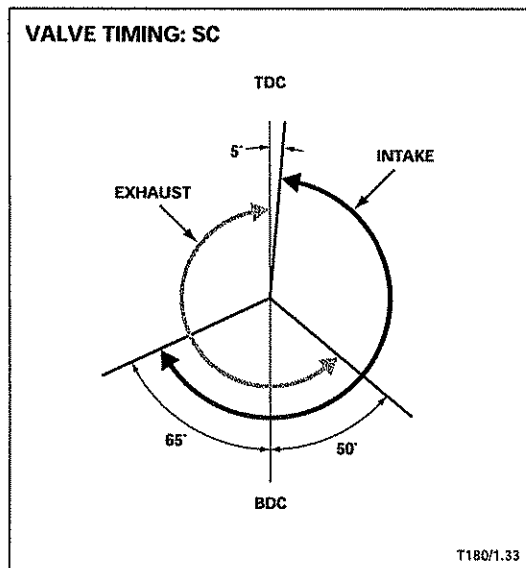
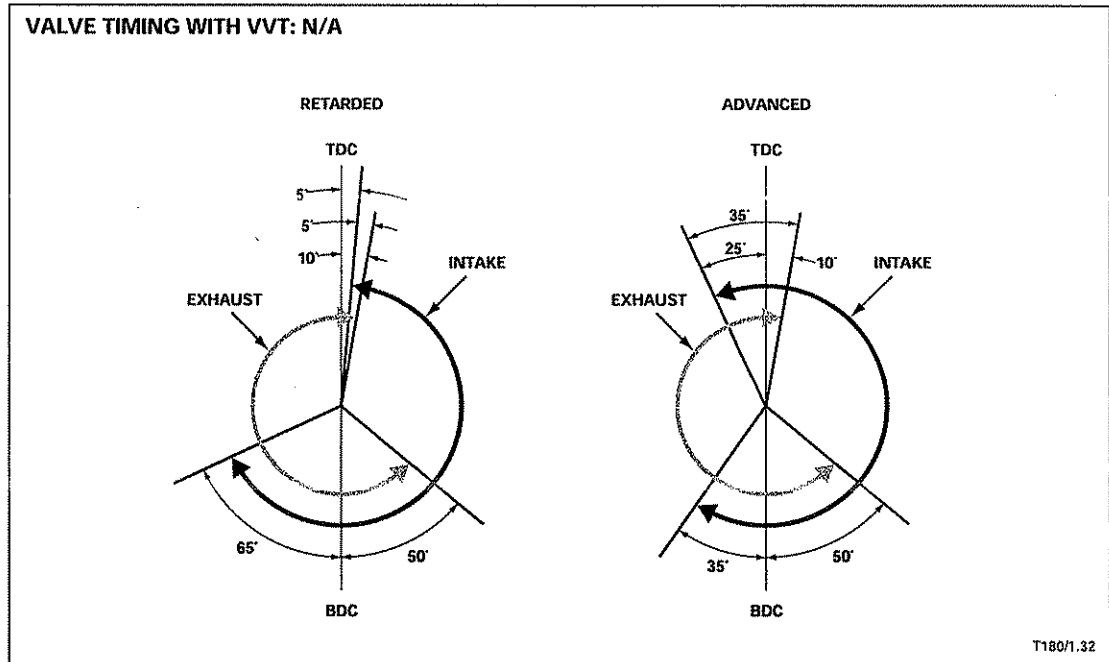


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Valve Timing

A variable valve timing system (VVT) is used on N/A engines to improve low and high speed engine performance, engine idle quality and exhaust emissions. Because of VVT, N/A engines do not require EGR. VVT is a two position system that operates on the intake camshafts only. There are 30° of crankshaft movement between the retarded and advanced positions.

Engine oil pressure operates the system under the control of the ECM. For each intake camshaft there is a valve timing unit, a bush carrier assembly and a valve timing solenoid.



Supercharged engine valve timing

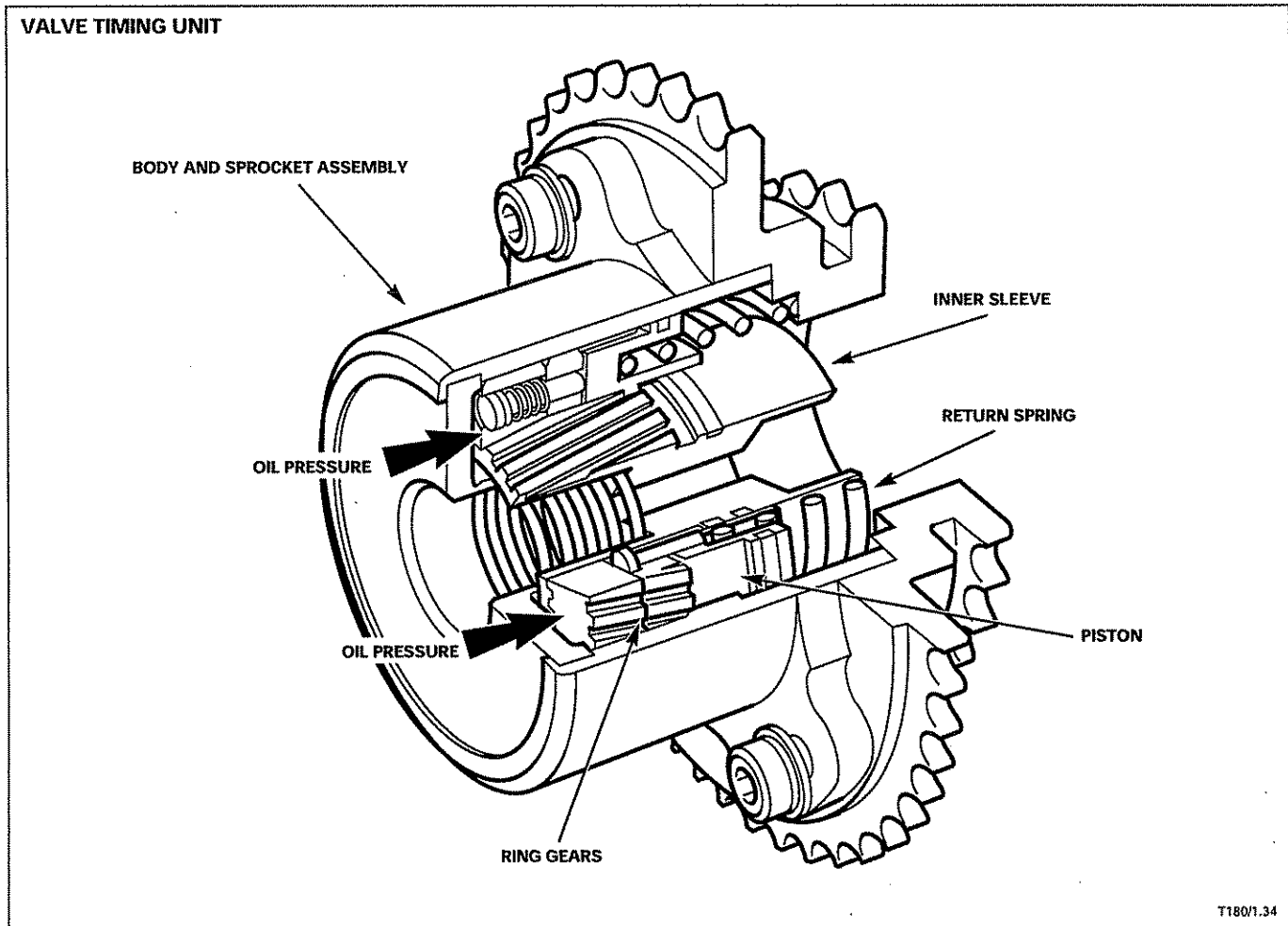
Supercharged engines are not equipped with variable valve timing. Because the additional manifold pressure boost provided by the supercharger substantially increases power and torque throughout the full operating range of the engine, it is not necessary to vary valve timing to provide additional overlap during mid engine speed operating conditions.

NOTES

Variable valve timing unit

The variable valve timing unit turns the intake camshaft in relation to the primary chain to advance and retard the timing.

The unit consists of a body and sprocket assembly separated from an inner sleeve by a ring piston and two 'O' ring gears. A bolt secures the inner sleeve to the camshaft. The ring gears engage in opposing helical splines on the body and sprocket assembly and on the inner sleeve.

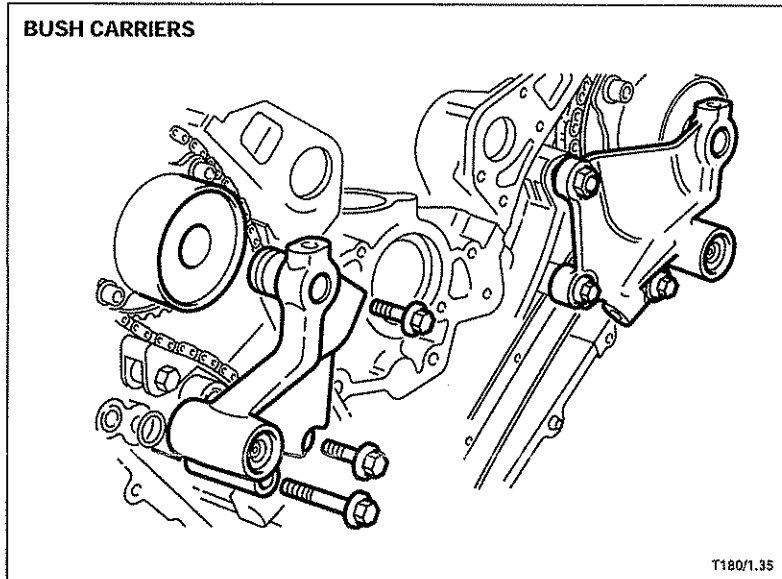


The ring gears transmit the drive from the body and sprocket assembly to the inner sleeve and, when moved axially, turn the inner sleeve in relation to the body and sprocket assembly.

Engine oil pressure moves the piston and ring gears to turn the inner sleeve in the advanced timing direction. A return spring moves the ring gears and piston to turn the inner sleeve in the retarded timing direction.

Additional springs absorb backlash to reduce noise and wear. The springs between the ring gears absorb rotational backlash. The spring between the inner sleeve and the end of the body and sprocket assembly absorbs axial backlash.

Valve Timing (continued)

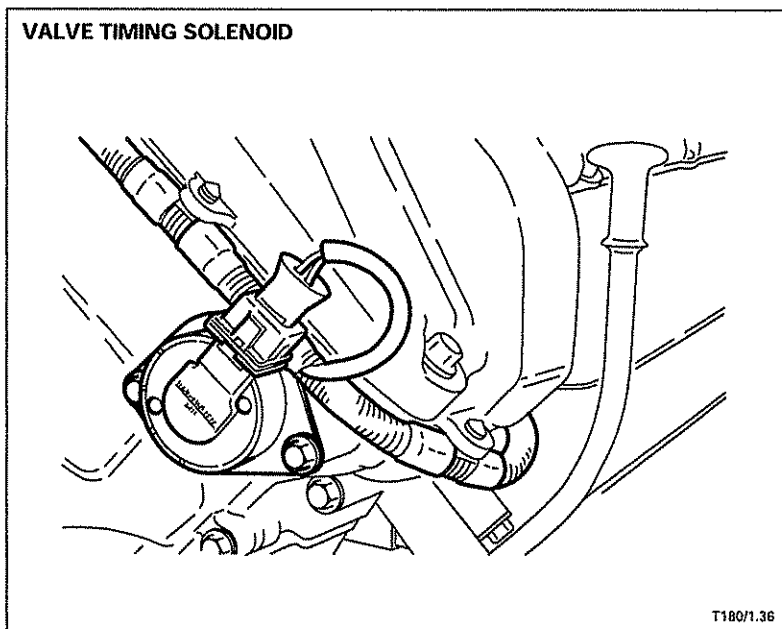


Bush carrier

The bush carrier contains oil passages that link the engine oil supply to the valve timing unit. A lug on the bush carrier locates in the central bore of the valve timing unit. Two hollow dowels at the bush carrier to cylinder block interface ensure the lug is accurately located. A scarf-jointed fiber ring seals the joint between the lug and the valve timing unit. An integral shuttle valve, biased by a coil spring, controls the flow of oil through the oil passages.

Valve timing solenoid

The valve timing solenoid controls the position of the shuttle valve in the bush carrier. A plunger on the solenoid extends when the solenoid is energized and retracts when the solenoid is de-energized.



NOTES

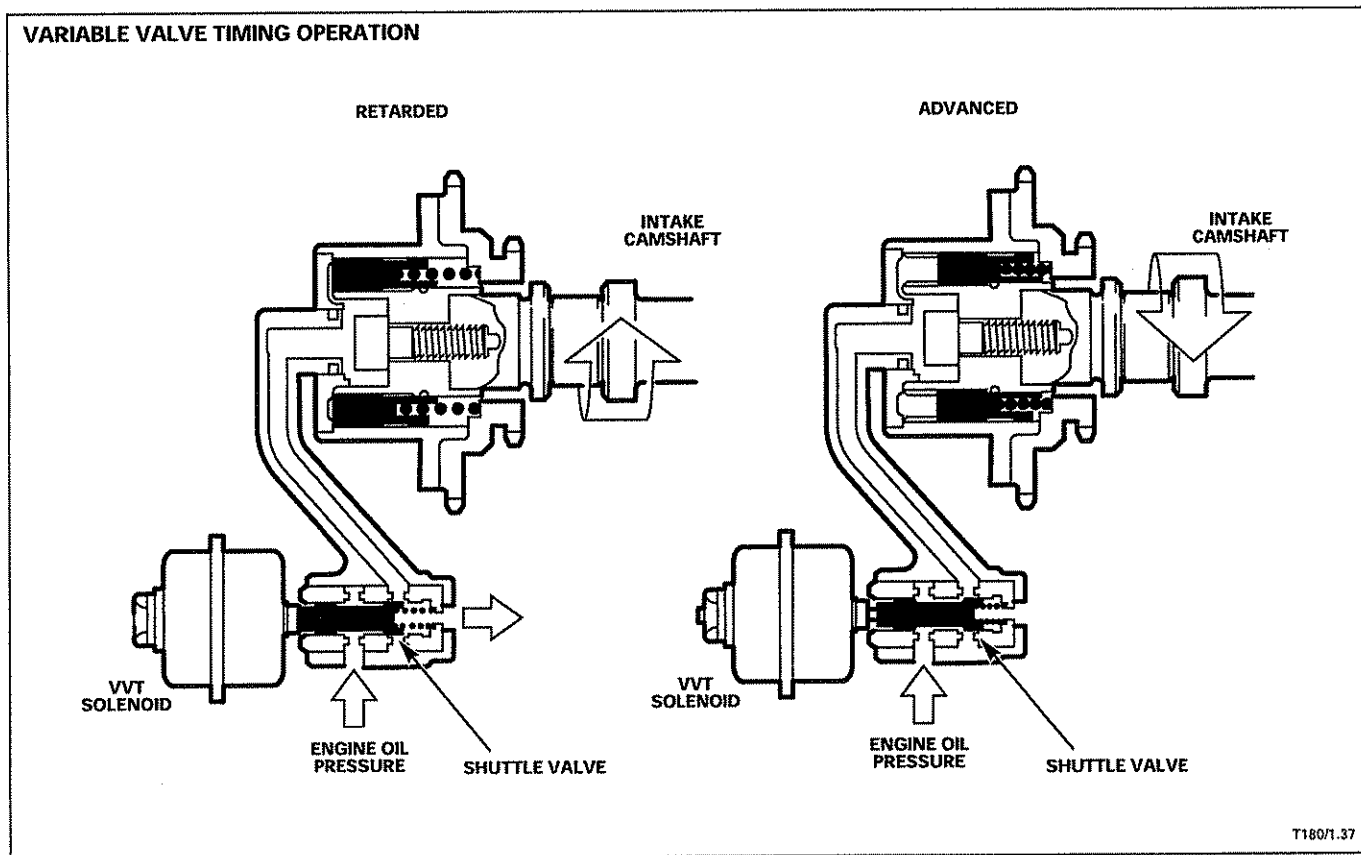
Variable Valve Timing Operation

When the valve timing solenoids are energized, the solenoid plungers position the shuttle valves to direct engine oil to the valve timing units. In the valve timing units, the oil pressure overcomes the force of the return springs and moves the gears and ring pistons to the advanced position.

System response times are 1.0 second maximum for advancing and 0.7 second maximum for retarding the camshaft timing.

While the valve timing is in the retarded mode, the ECM produces a periodic lubrication pulse. This pulse momentarily energizes the valve timing solenoids to allow a spurt of oil into the valve timing units. The lubrication pulse occurs once every 5 minutes.

NOTE: With the vehicle stationary and the hood open, operation of the valve timing solenoids may be audible when the lubrication pulse occurs at engine idle speed.



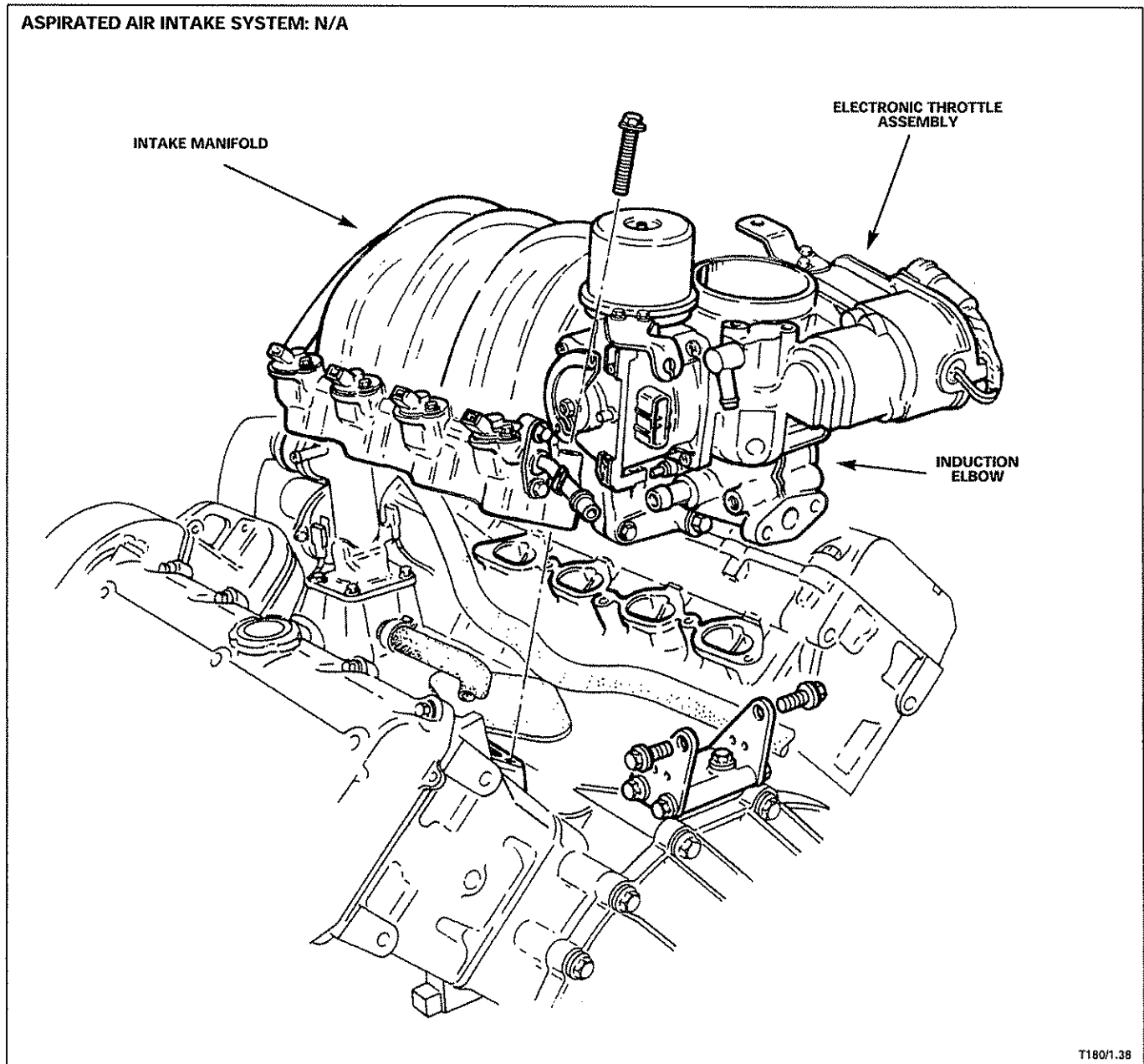
NOTES

AJV8 Engine Overview

Air Intake System

Normally Aspirated Air Intake System

Filtered air from the vehicle's intake ducting is metered by the electronic throttle, then directed through the induction elbow into the intake manifold.



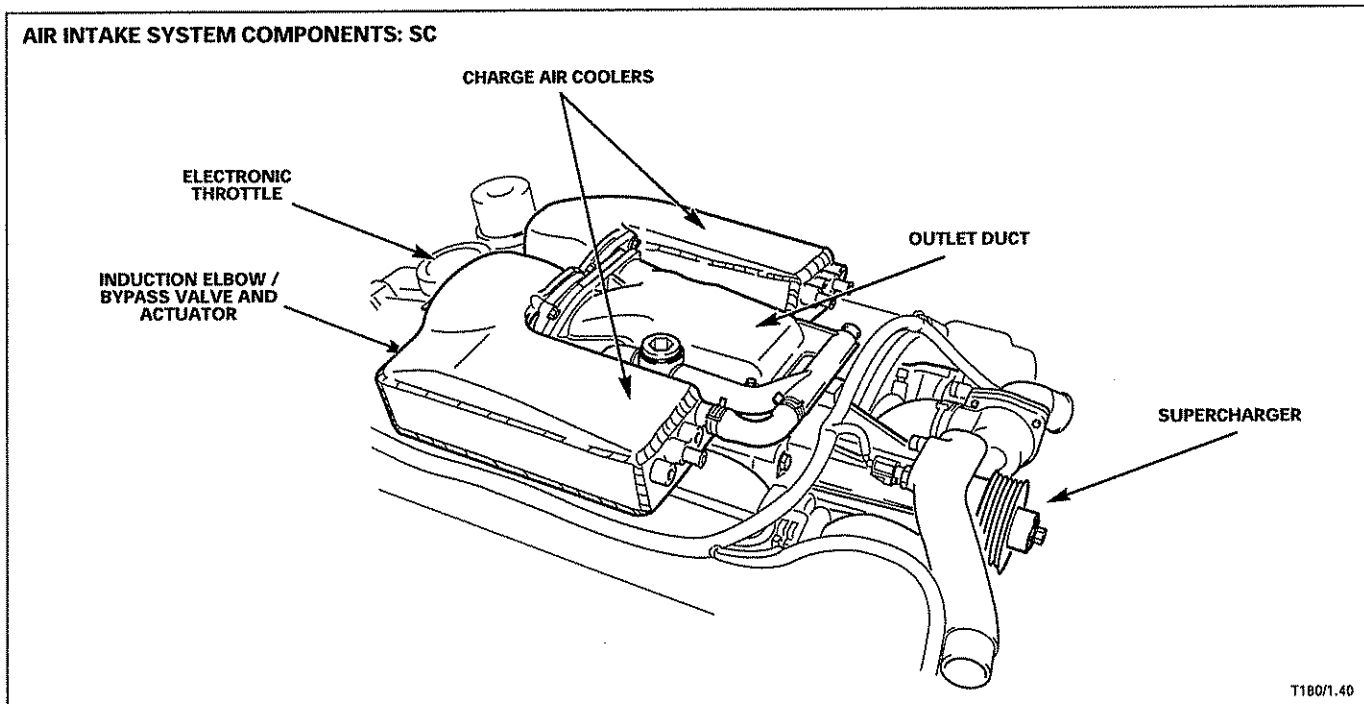
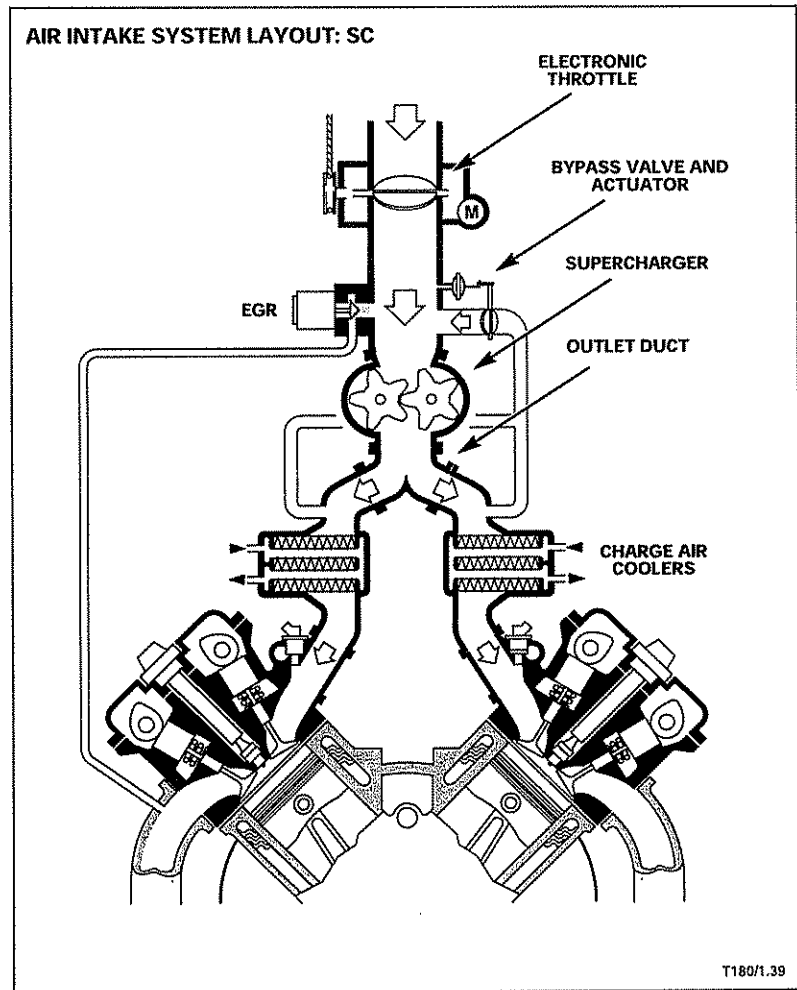
NOTES

Supercharged Air Intake System

Combustion air, metered by the electronic throttle, passes through the induction elbow to the supercharger. Depending on engine operating demands, the supercharger increases the air pressure up to a maximum of 0.8 bar (11.6 psi) above atmospheric pressure. The pressurized air is cooled by the charge air coolers on its way to the cylinders.

A vacuum controlled bypass valve attaches to an opening in the induction elbow to control bypass air flow from the charge air coolers to the supercharger intake to regulate boost pressure.

NOTES



AJV8 Engine Overview

Engine Specifications

Except where noted, specifications are for both normally aspirated and supercharged engines.

Configuration	90° V8
Number of cylinders	8 (two banks: 'A' bank right, 'B' bank left, cylinder number 1 at front)
Displacement	3996 cc (243.9 cu. in.)
Engine weight	
Normally aspirated	200 kg (441 lb.)
Supercharged	227 kg (500 lb.)
Bore and stroke	86 mm x 86 mm (3.386 in. x 3.386 in.)
Cylinder head	4 valves per cylinder
Compression ratio	
Normally aspirated	10.75 : 1
Supercharged	9.00 : 1
Power output	
Normally aspirated	Horsepower (DIN) 290 @ 6100 rpm Torque 393 Nm (290 lb. ft.) @ 4250 rpm
Supercharged	Horsepower (DIN) 365 @ 6000 rpm Torque 525 Nm (384 lb. ft.) @ 3600 rpm
Firing order	1A, 1B, 4A, 2A, 2B, 3A, 3B, 4B
Valve clearances (cold)	Intake 0.20 mm (0.008 in.) Exhaust 0.25 mm (0.010 in.)
Compression pressure	12 bar (180 psi) ± 10%
Spark plugs	
Normally aspirated	PFR56 - 13E gap 1.3 mm (0.051 in.)
Supercharged	PFR66 - 13E gap 1.3 mm (0.051 in.)
Valve operation	
Normally aspirated	Twin overhead camshafts; chain driven Hydraulically actuated two position variable valve timing for intake camshafts
Supercharged	No variable valve timing
Crankshaft	
Number of main bearings journals	5
Main bearing journal diameter	62 mm (2.441 in.)
Main bearing width	20 mm (0.787 in.)
Main bearing oil clearance	0.025 - 0.050mm (0.001- 0.002 in.)
Crankshaft end float	0.07 - 0.27 mm (0.0027 - 0.010 in.)
Number of connecting rod journals	4
Connecting rod journal diameter	56 mm (2.204 in.)
Connecting rod bearing width	16 mm (0.630 in.)
Connecting rod bearings oil clearance	0.035 - 0.063 mm (0.0014 - 0.0025 in.)
Connecting rods	
Number of connecting rods	8
Center to center dimension	151.75 mm (5.974 in.)

Pistons

Bare weight 334 ± 5 g (11.75 ± 0.18 oz.)

Piston rings

Top Barrel faced plasma sprayed compression
 Middle Napier taper compression
 Bottom Two piece spring assisted oil control

Valves

Valve stem diameter 5 mm (0.197 in.)
 Valve head diameter Intake 34.9 mm (1.374 in.)
 Exhaust 30.9 mm (1.217 in.)
 Valve lift 9.0 mm (0.354 in.)

Valve springs

Free length 45.5 mm (1.791 in.) maximum

Valve timing

Normally aspirated
 Intake opens retarded – 5° ATDC
 advanced – 25° BTDC
 Intake closes retarded – 65° ABDC
 advanced – 35° ABDC
 Exhaust closes 50° BBDC
 Exhaust opens 10° ATDC
 Supercharged
 Intake opens 5° ATDC
 Intake closes 65° ABDC
 Exhaust closes 50° BBDC
 Exhaust opens 10° ATDC

Camshafts

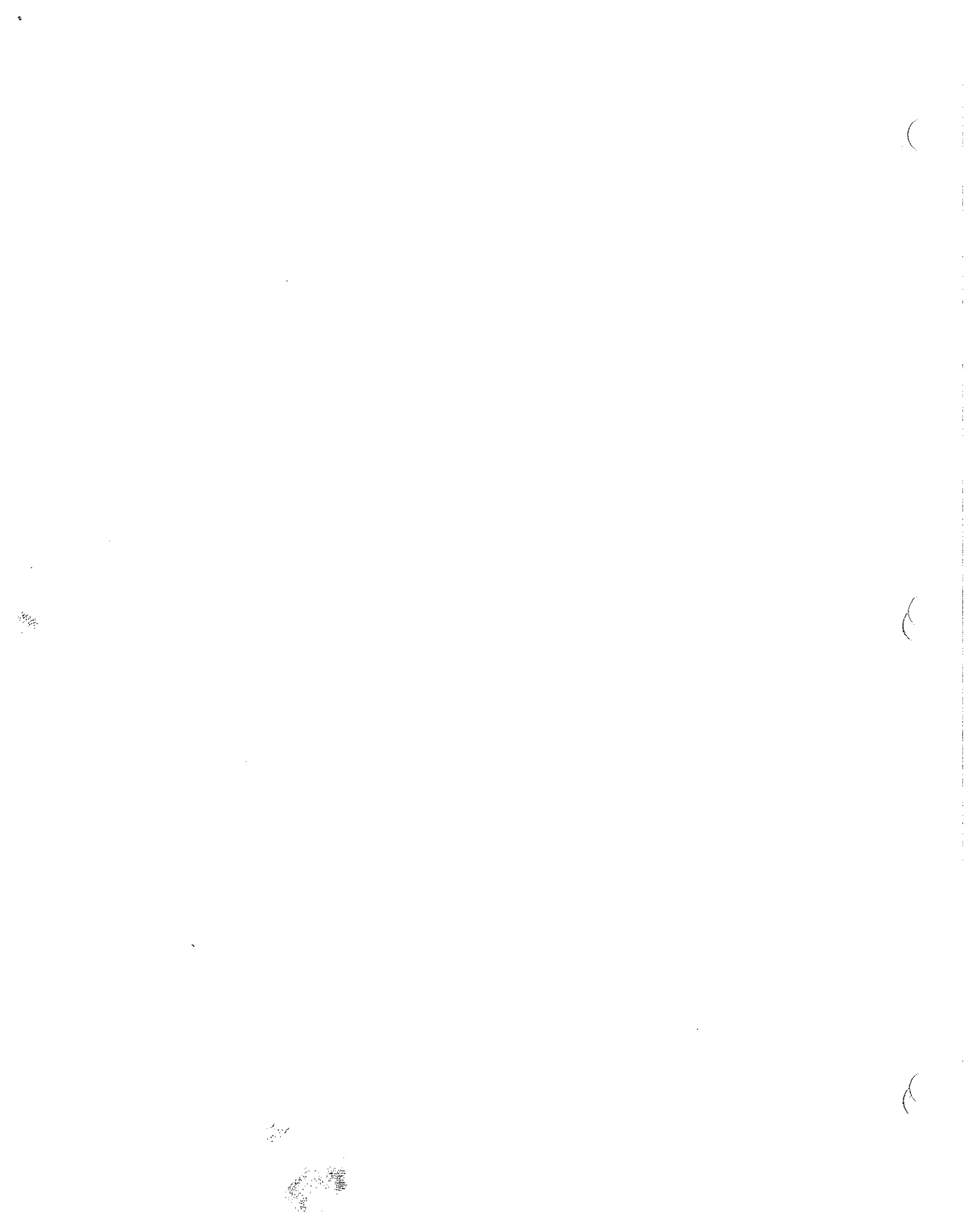
Bearing diameters 30 mm (1.181 in.)

Timing gear

Primary timing chain Single roller chain endless riveted 106 links
 Crankshaft timing sprocket 19 teeth
 Intake camshaft primary sprocket 38 teeth
 Secondary timing chain Single roller chain endless riveted 44 links
 Intake camshaft secondary sprocket 23 teeth
 Exhaust camshaft secondary sprocket 23 teeth

Lubrication system

Oil capacity Without oil cooler – 6.5 liters (6.87 qt.)
 With oil cooler – 7.3 liters (7.71 qt.)
 Oil pressure 3000 rpm / hot – 3.8 bar (55.1 psi)
 Idle / hot – 0.7 bar (10.15 psi)
 Maximum oil flow 45 liter / min. (10 gallons / min.)
 Maximum oil pressure 6.8 bar (98.6 psi)
 Oil pressure relief valve 4.5 bar (65.25 psi)
 Oil pressure switch operation 0.15 – 0.41 bar (2.17 – 6 psi)
 Oil diverter valve (oil cooler engine only)
 Start opening 105 °C (221 °F)
 Fully open 119 °C (246 °F)

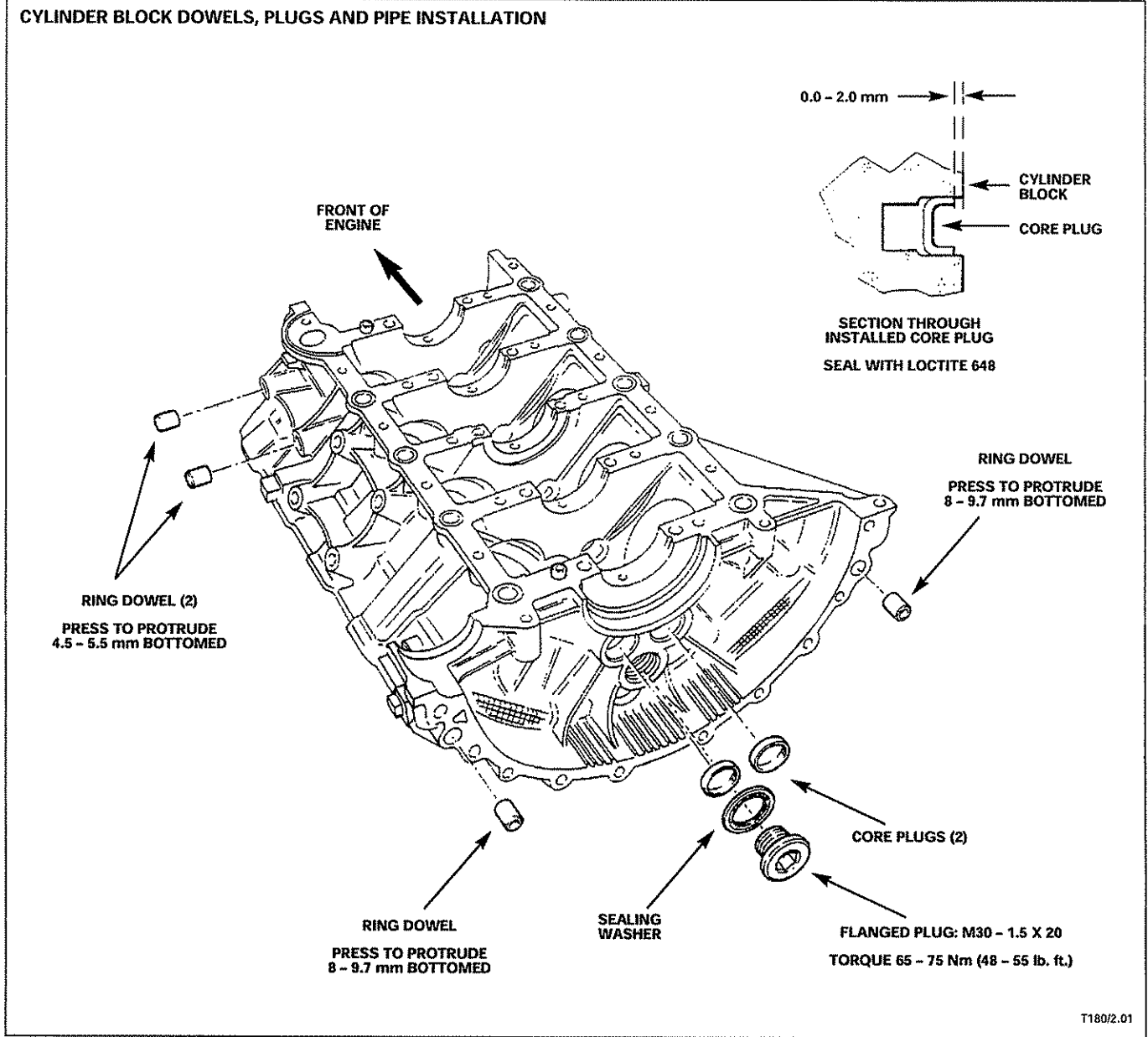


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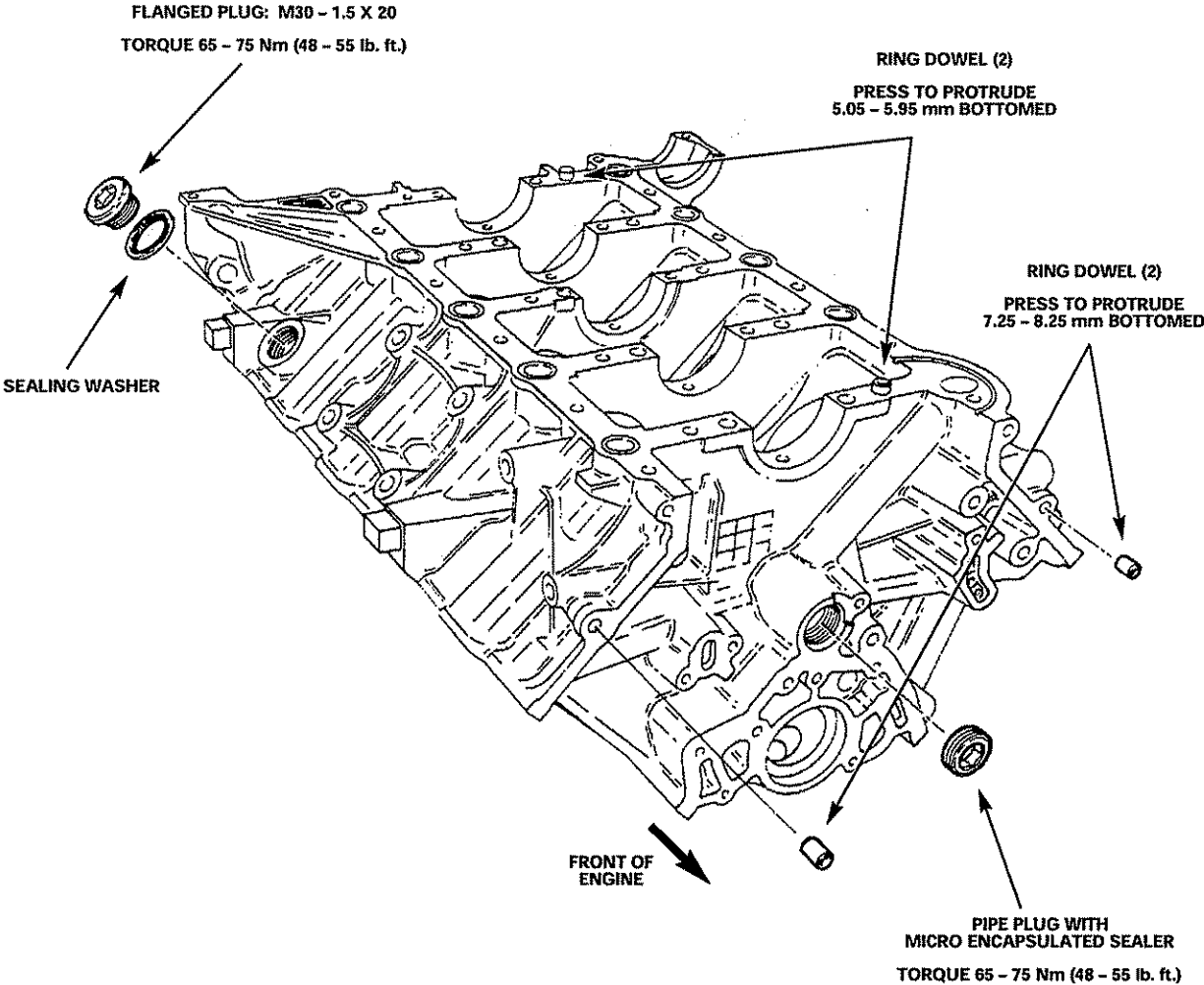
AJV8 Engine Assembly

Cylinder Block Dowels, Plugs and Pipes



NOTES

CYLINDER BLOCK DOWELS, PLUGS AND PIPE INSTALLATION

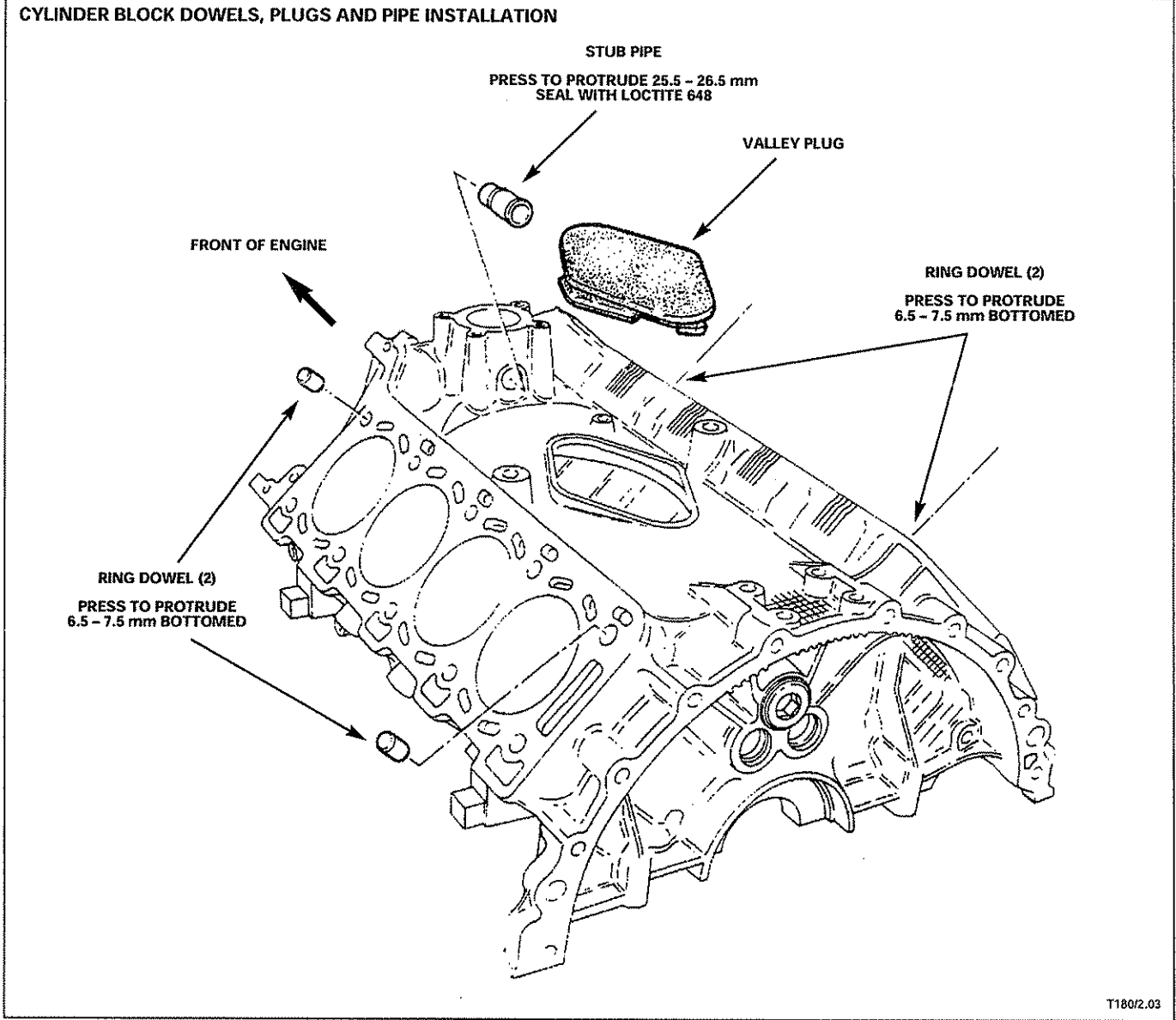


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NOTES

AJV8 Engine Assembly

Cylinder Block Dowels, Plugs and Pipes (continued)

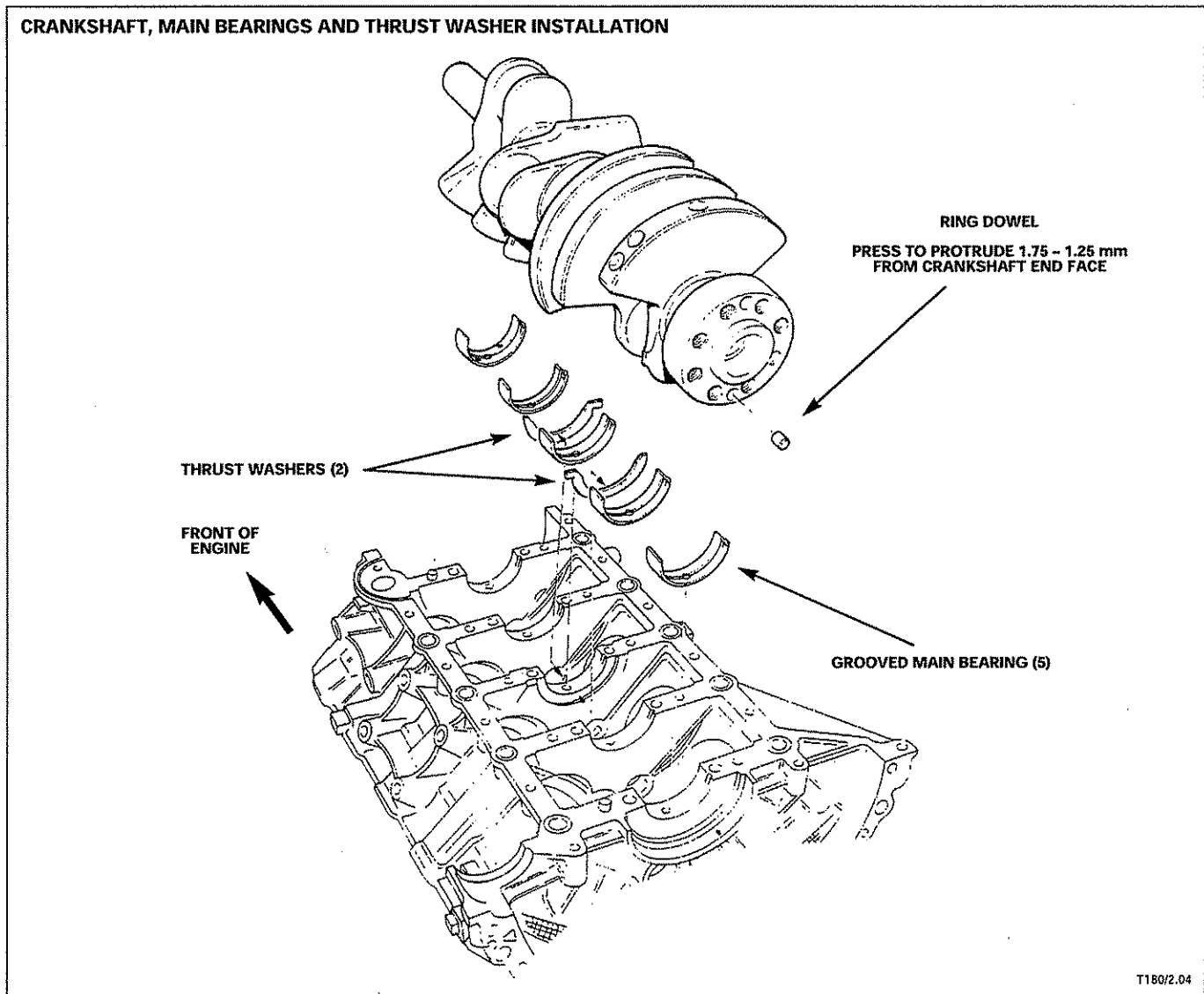


NOTES

Crankshaft Bearing and Cylinder Bore Dimensions

Crankshaft main bearings and connecting rod bearings must be selected to achieve the correct oil clearance. Cylinder block / bed plate main bearings bores and crankshaft main and connecting rod journal diameters are measured during engine manufacturing to 0.001 mm (0.00004 in.) tolerances. Because accurately measuring to these tolerances is extremely difficult under workshop conditions, the dimensions are stamped on the engine as codes during manufacturing.

Finished pistons and cylinder bores are also measured and graded electronically during manufacture. Any excess wear to the cylinder bore will be evident by visually inspecting the Nikasil finish. If damage to the finish is evident, the cylinder block must be replaced.



NOTES

AJV8 Engine Assembly

Crankshaft Bearing and Cylinder Bore Dimensions (continued)

Bearing measuring

Main bearing bore measuring

Main bearing bores are measured at two places in the center of the bearing area. Each measurement is at 45° from the cylinder block / bed plate joint.

Crankshaft journal measuring

Each crankshaft journal is measured dynamically at the middle of the bearing area.

Engine Dimension Codes

Following is an explanation of the codes stamped on the engine. The actual diameter measurements represented by the diameter codes are listed in the chart on page 7.

Crankshaft code: *LJDEH*BBBB*

LJDEH: Main bearing crankshaft journal diameter

Diameter code	L	J	D	E	H
Journal #	1	2	3	4	5

Main bearing journal orientation: #1 – front; #5 – rear

BBBB: Connecting rod journal diameter

Diameter code	B	B	B	B
Journal #	1	2	3	4

Connecting rod journal orientation: #1 – front; #4 – rear

Handwritten notes:
 3 / K / L / H / H
 61.993 / 61.991 / 61.990 / 61.989 / 61.988

Block code: *22112222*SSRRR*

22112222: Cylinder bore diameter

Diameter grade	2	2	1	1	2	2	2	2
Cylinder #	B1	B2	B3	B4	A4	A3	A2	A1

Cylinder bore orientation: 'B' bank – left side; #1 – front

SSRRR: Main bearing bore inside diameter

Diameter code	S	S	R	R	R
Bearing #	1	2	3	4	5

Main bearing bore orientation: #1 – front; #5 – rear

Engine Number

Engine number example: 9704051158

97	04	05	1158
(year)	(month)	(day)	(time)

NOTES

AJV8 Engine Assembly

Main bearing crankshaft journal diameter codes

Code	Diameter: mm	(in.)	Code	Diameter: mm	(in.)
A	62.000	(2.44094)	M	61.989	(2.44051)
B	61.999	(2.44091)	N	61.988	(2.44047)
C	61.998	(2.44087)	P	61.987	(2.44043)
D	61.997	(2.44083)	R	61.986	(2.44039)
E	61.996	(2.44079)	S	61.985	(2.44035)
F	61.995	(2.44075)	T	61.984	(2.44031)
G	61.994	(2.44071)	V	61.983	(2.44028)
H	61.993	(2.44067)	W	61.982	(2.44024)
J	61.992	(2.44063)	X	61.981	(2.44020)
K	61.991	(2.44059)	Y	61.980	(2.44016)
L	61.990	(2.44055)	Z	61.979	(2.44012)

Connecting rod journal diameter codes

Code	Diameter: mm	(in.)
A	56.000 – 55.994	(2.20472 – 2.20449)
B	55.994 – 55.988	(2.20449 – 2.20425)
C	55.988 – 55.982	(2.20425 – 2.20402)

Main bearing bore inside diameter codes

Code	Diameter: mm	(in.)	Code	Diameter: mm	(in.)
A	66.032	(2.59969)	L	66.022	(2.59929)
B	66.031	(2.59965)	M	66.021	(2.59925)
C	66.030	(2.59961)	N	66.020	(2.59921)
D	66.029	(2.59957)	P	66.019	(2.59917)
E	66.028	(2.59953)	R	66.018	(2.59913)
F	66.027	(2.59949)	S	66.017	(2.59909)
G	66.026	(2.59945)	T	66.016	(2.59906)
H	66.025	(2.59941)	V	66.015	(2.59902)
J	66.024	(2.59937)	W	66.014	(2.59898)
K	66.023	(2.59933)			

Piston / cylinder bore grades

Code	Diameter: mm	(in.)
1	85.973 – 85.987	(3.38476 – 3.38531)
2	85.983 – 85.997	(3.38516 – 3.38571)
3	85.993 – 86.007	(3.38555 – 3.38610)

NOTE: Piston and cylinder bore grade must match.

NOTES

Crankshaft Bearing and Cylinder Bore Dimensions (continued)

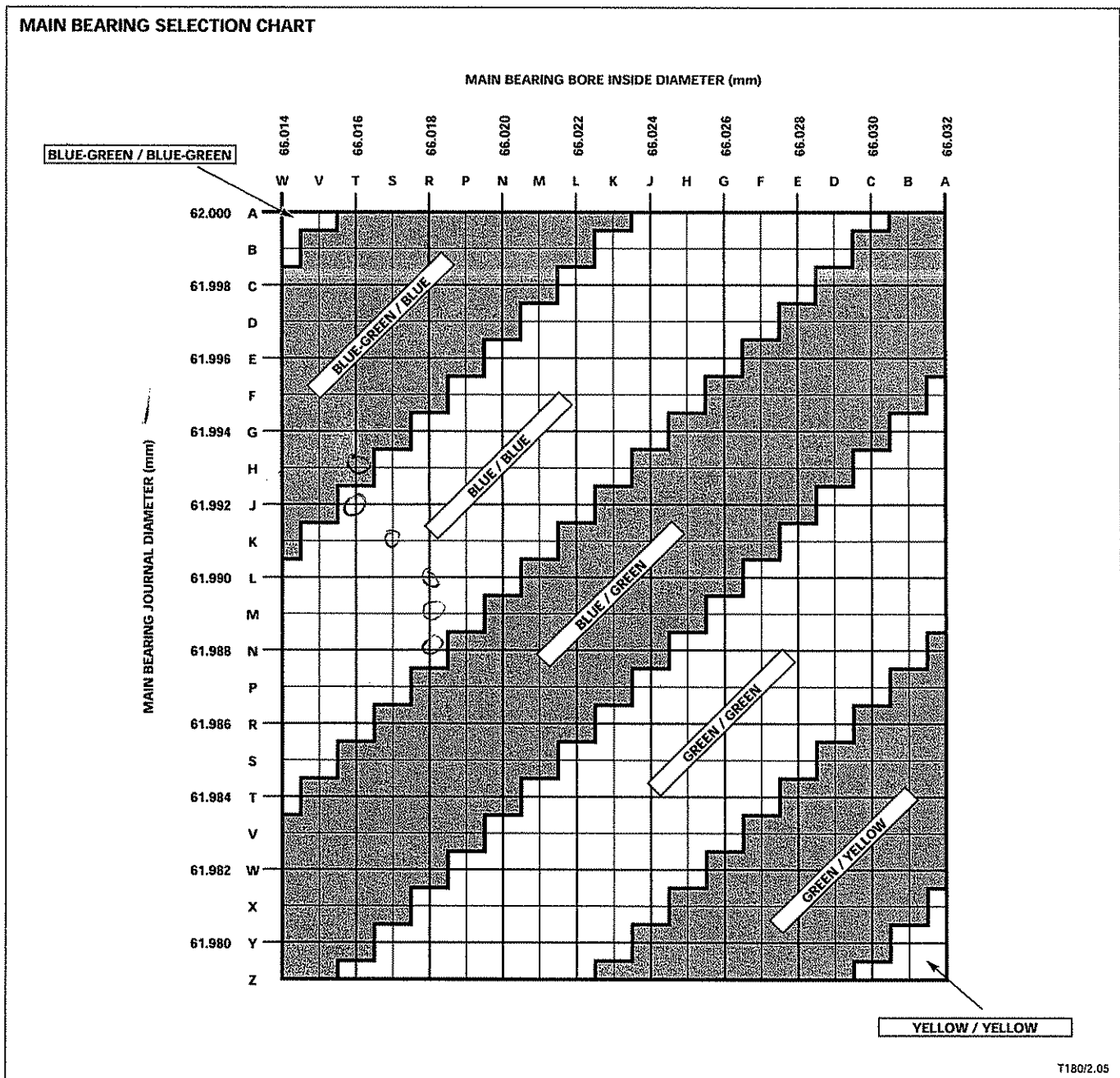
Main Bearing Selection

To select the correct bearings, find the main bearing codes for the journal or the measured main bearing bore and journal diameter on the chart. The intersection of the two dimensions indicates the color code of the required bearing inserts. If two different color bearing inserts are required, they can be positioned in either the crankcase or bed plate.

⚠ CAUTION: A grooved bearing must always be positioned in the crankcase to provide lubrication for the connecting rod bearings.

Main bearing oil clearance

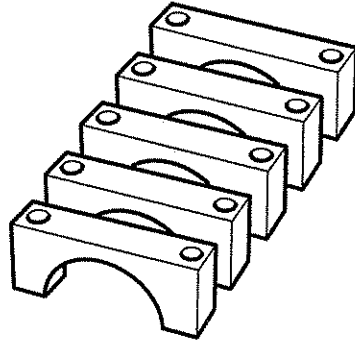
0.025 – 0.050 mm (0.001 – 0.002 in)



Crankshaft Installation

Place the crankshaft in position and install 5 dummy main bearing cap tools number JD 220 to hold the bearings and crankshaft in position when fitting the piston / connecting rod assemblies.

MAIN BEARING DUMMY CAP TOOL JD 220



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NOTES

N P L R R

N - 13G

K - 13B

J -

K -

H -

T	S	R	R	R
66.016	66.017	66.018		

J 61.998

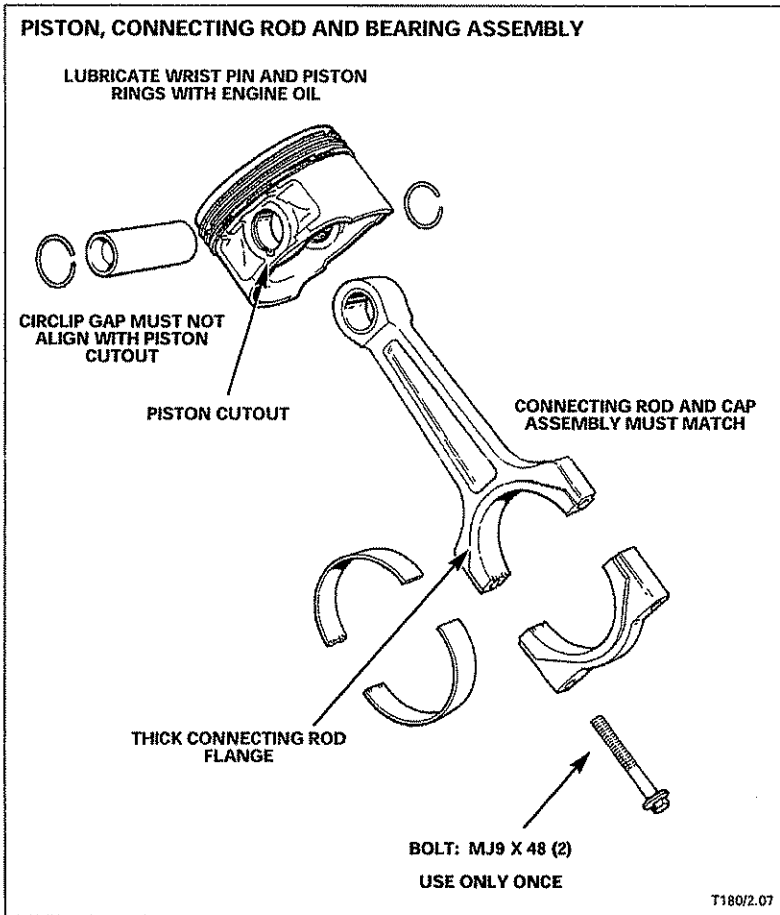
K 61.991

L 61.990

M 61.989

N 61.988

Pistons, Connecting Rods and Bearings



Pistons

The piston grade code stamped on each piston crown must be the same as the cylinder block grade code for the cylinder.

Any excess wear to the cylinder bore will be evident by visually inspecting the Nikasil finish. If damage to the finish is evident, the cylinder block must be replaced.

'A' bank piston and connecting rod assemblies: arrow on piston and thick flange of connecting rod must face the same direction.

'B' bank piston and connecting rod assemblies: arrow on piston and thin flange of connecting rod must face the same direction.

Piston rings

Each piston is fitted with three rings:

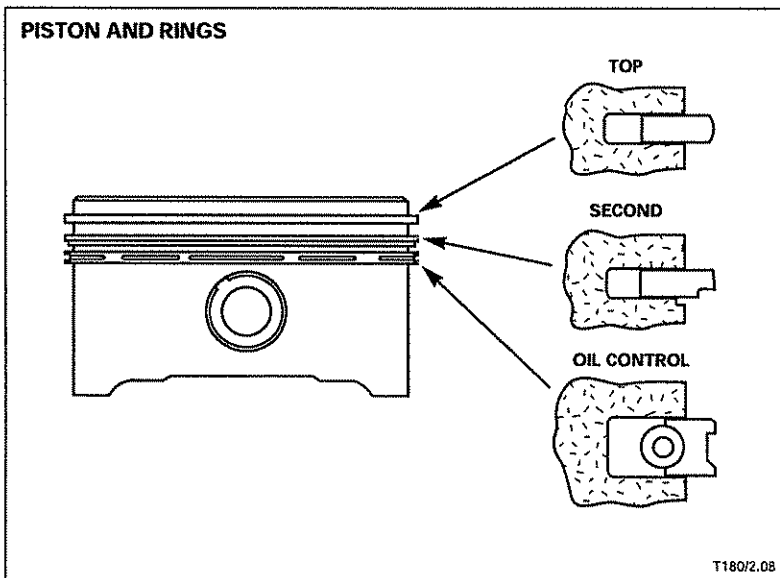
- Top compression ring
- Stepped second compression ring - install with step facing down
- Two-piece oil control ring

Install as shown in the illustration. Align piston ring gaps at least 90° apart.

Connecting Rods

Connecting rods must be fitted to the cylinder position marked on the rod and the cap.

Each connecting rod has a thick flange and a thin flange. The thin flange side of the connecting rod is also marked with a dimple adjacent to the bearing. Connecting rods are installed on their journals with the dimples (thin flanges) facing each other.



NOTES

Install the correct bearing shell in the connecting rod and fit bore protector tools JD 221. Lubricate the piston and install the assembly.

Connecting rod bearing selection chart

Code	Connecting rod journal diameter: mm (in.)	Bearing Grade Color
A	55.994 – 56.000 mm (2.20449 – 2.20472 in.)	Blue
B	55.988 – 55.994 mm (2.20425 – 2.20449 in.)	Green
C	55.982 – 55.988 mm (2.20402 – 2.20425 in.)	Yellow

Lubricate the connecting rod cap bearing with two 4 mm drops of EP 90, install and torque the cap bolts in three steps:

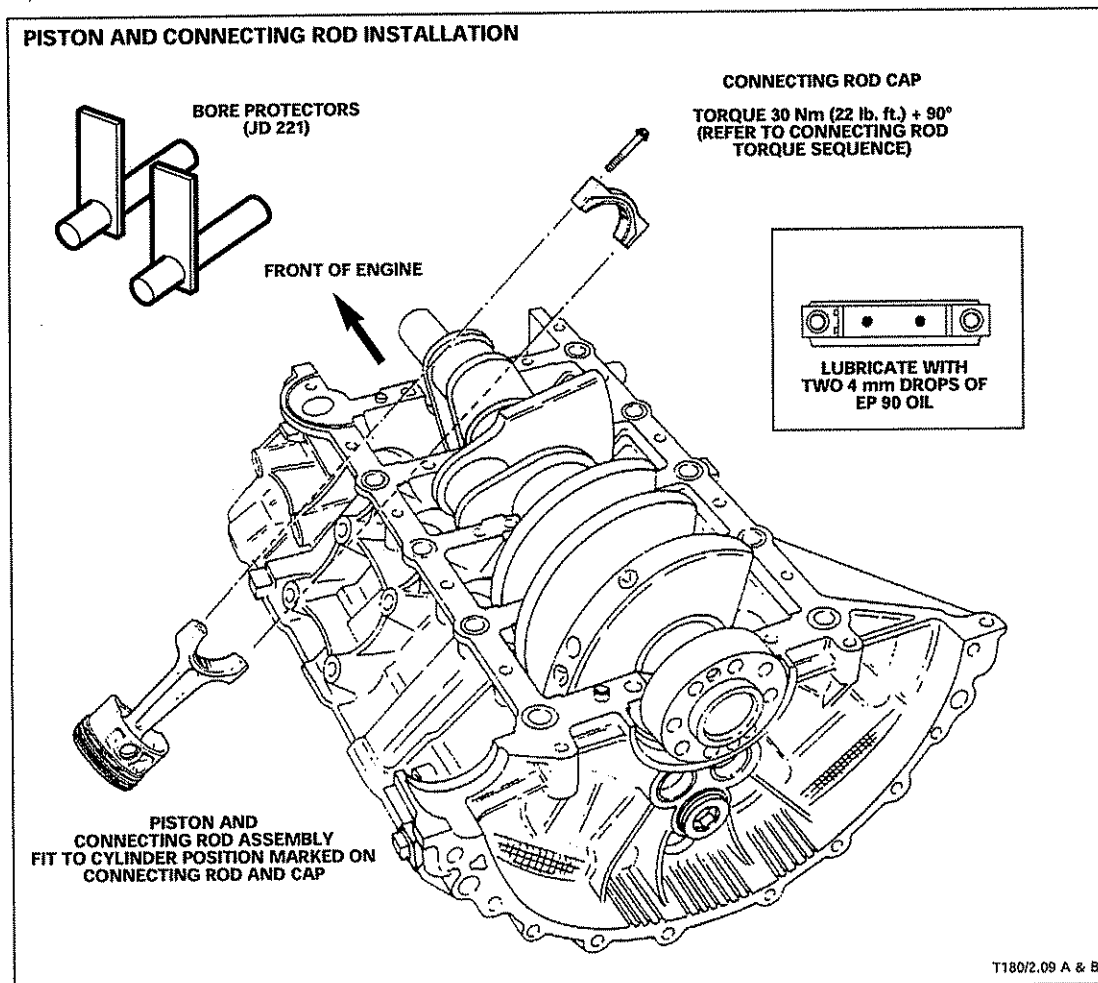
Connecting rod bolt torque sequence

- Step 1 Torque connecting rod bolts to 8 –12 Nm
- Step 2 Torque connecting rod bolts to 30 Nm
- Step 3 Tighten connecting rod bolts an additional 90°

Center punch bolt heads once completely torqued. Do not reuse bolts.

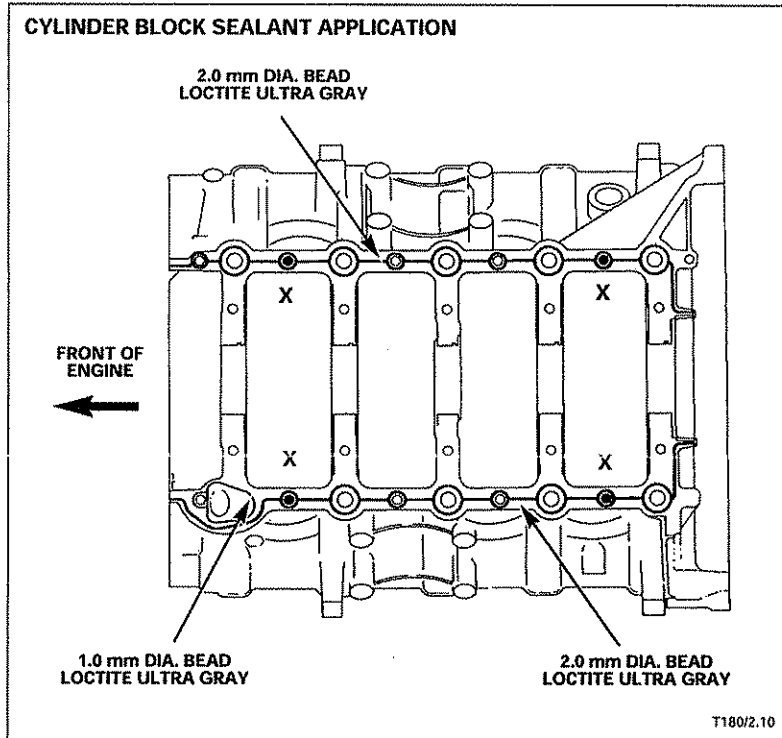
Connecting rod bearing to journal oil clearance

0.035 – 0.063 mm (0.0014 – 0.0025 in)



AJV8 Engine Assembly

Bed Plate



Cylinder Block to Bed Plate Installation

Cylinder block and bed plate joints must be clean and free from oil.

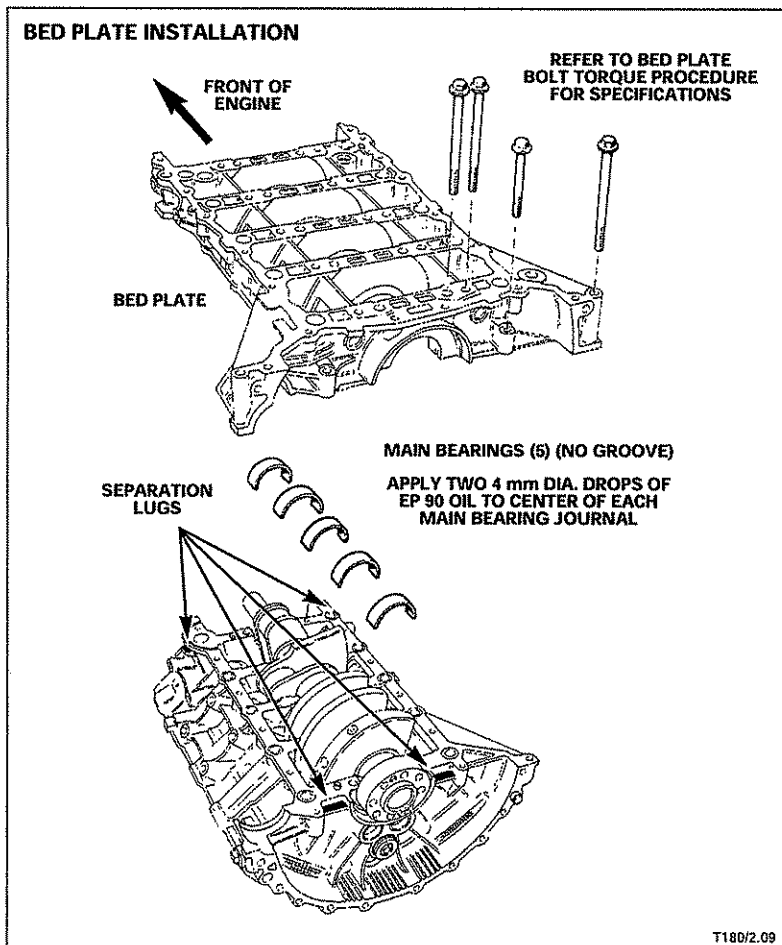
Apply two 4 mm drops of EP 90 Oil to each crankshaft journal in the middle of the bearing length.

Apply a continuous bead of Loctite Ultra Gray 5699 RTV sealant to the cylinder block as shown on the illustration, with the diameter of the bead as indicated. 1 mm gaps are allowed around the oil drain holes. Gaps of 3 mm are allowed elsewhere.

Within 7 minutes of initial sealant application, install the bed plate and the four new M8 x 60 bolts (indicated by an X on the illustration). Torque the four bolts to 7 - 9 Nm (5 - 6.5 lb ft).

Within 20 minutes of initial sealant application, the rest of the bed plate bolts must be installed and torqued following the procedure on page 13.

Remove any excess sealant from the block and the crankshaft main bearing seal bore.



NOTE: If the operation is not completed within 20 minutes of initial sealant application, separate the bed plate from the block. Clean the joints with a plastic or wooden scraper and repeat the procedure.

CAUTION: Use only the cast separation lugs to separate the bed plate from the block.

NOTES

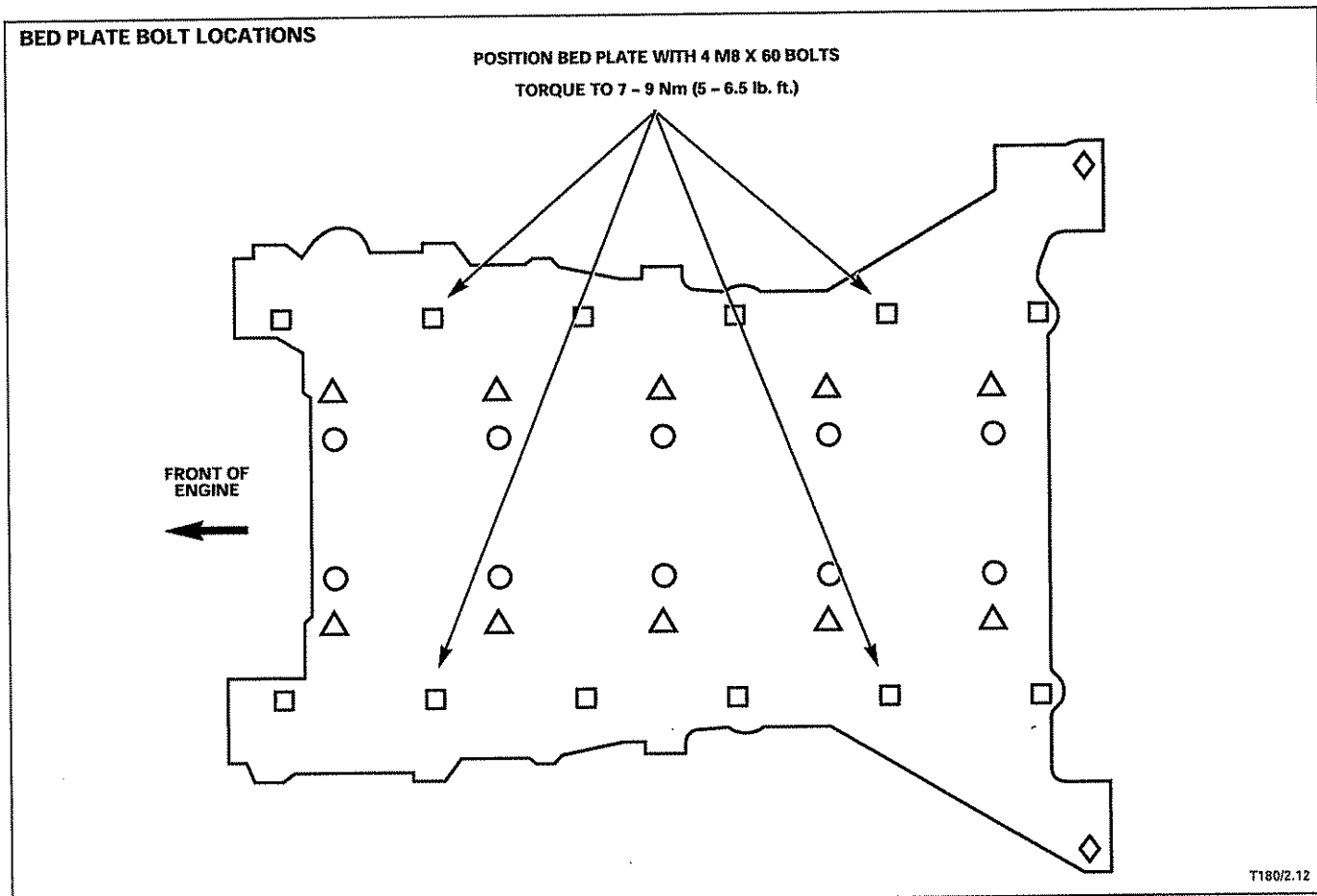
Bed plate bolt torque procedure

- | | |
|-------------------------|---------------------------|
| □ 'P' bolt M8 x 60 (12) | ○ 'M' bolt M10 x 114 (10) |
| ◇ 'F' bolt M8 x 110 (2) | △ 'S' bolt M8 x 110 (10) |

Torque specifications

- Step 1 □ 'P' bolts: torque to 14 – 16 Nm (10.5 – 12 lb ft)
- Step 2 ◇ 'F' bolts: torque to 14 – 16 Nm (10.5 – 12 lb ft)
- Step 3 ○ 'M' bolts: torque to 24 – 26 Nm (18 – 19 lb ft)
- Step 4 △ 'S' bolts: torque to 14 – 16 Nm (10.5 – 12 lb ft)
- Step 5 ○ 'M' bolts: torque to 34 – 36 Nm + 135° (25 – 26.5 lb ft + 135°)
- Step 6 △ 'S' bolts: torque to 19 – 21 Nm + 150° (14 – 15.5 lb ft + 150°)
- Step 7 □ 'P' bolts: torque to 19 – 21 Nm + 90° (14 – 15.5 lb ft + 90°)
- Step 8 ◇ † ' bolts: torque to 19 – 21 Nm + 150° (14 – 15.5 lb ft + 150°)

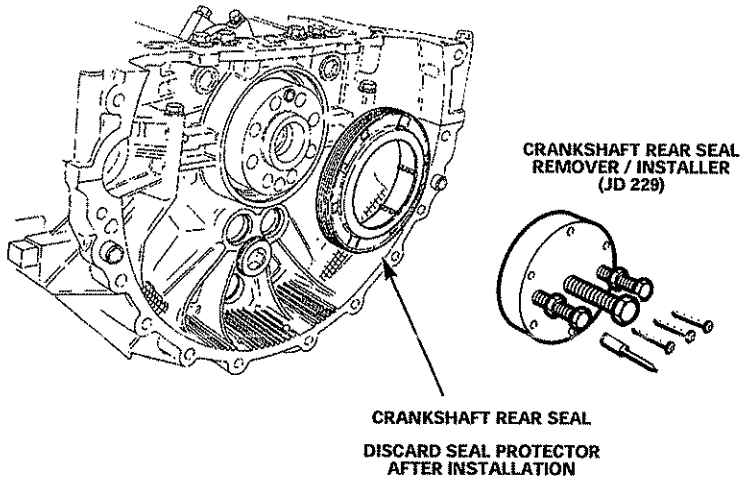
NOTE: Bed plate bolts must be center punched after being completely torqued. Center punched bolts must not be reused.



AJV8 Engine Assembly

Oil Pump, Crankshaft Sprocket and Seal

SHAFT REAR SEAL INSTALLATION



T180/2.13 A & B

Crankshaft Rear Seal Installation

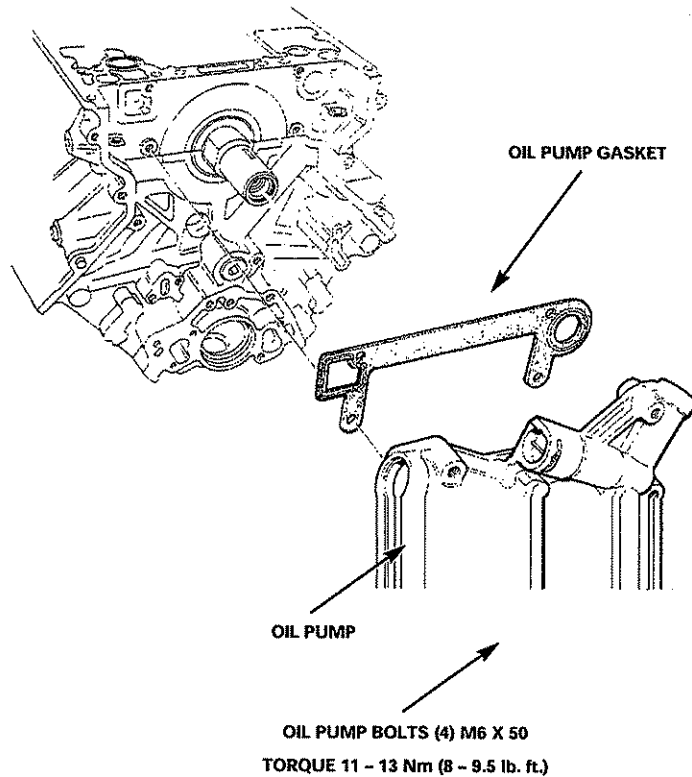
Press the seal into the housing with tool JD 229. Maintain insertion load for 3 – 5 seconds at fitted depth. Outer face of the seal must be parallel to the crankshaft rear face within 0.3 mm (0.012 in.).

Oil Pump Installation

Install the oil pump gasket dry. The pump must engage with the drive flats on the crankshaft.

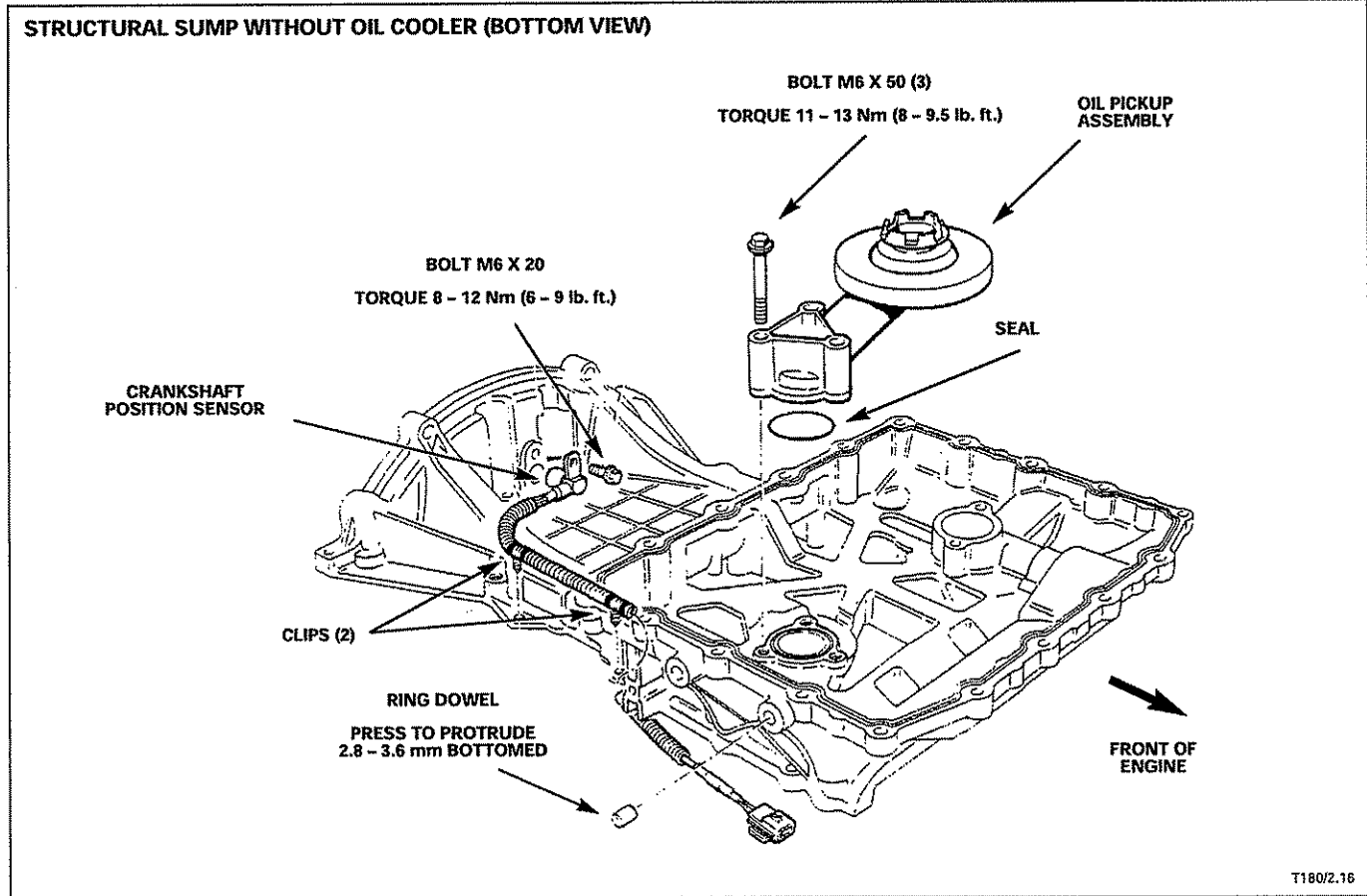
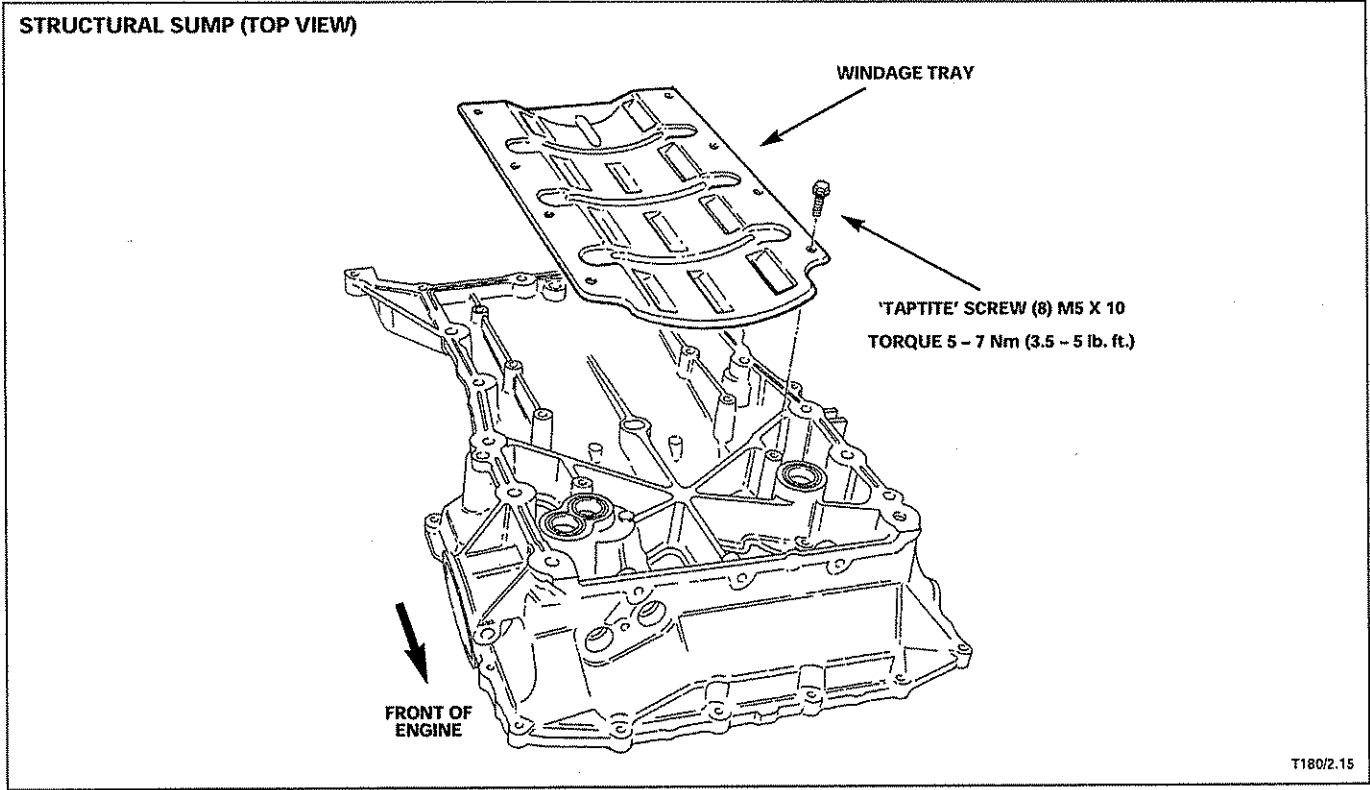
NOTES

OIL PUMP INSTALLATION



T180/2.14

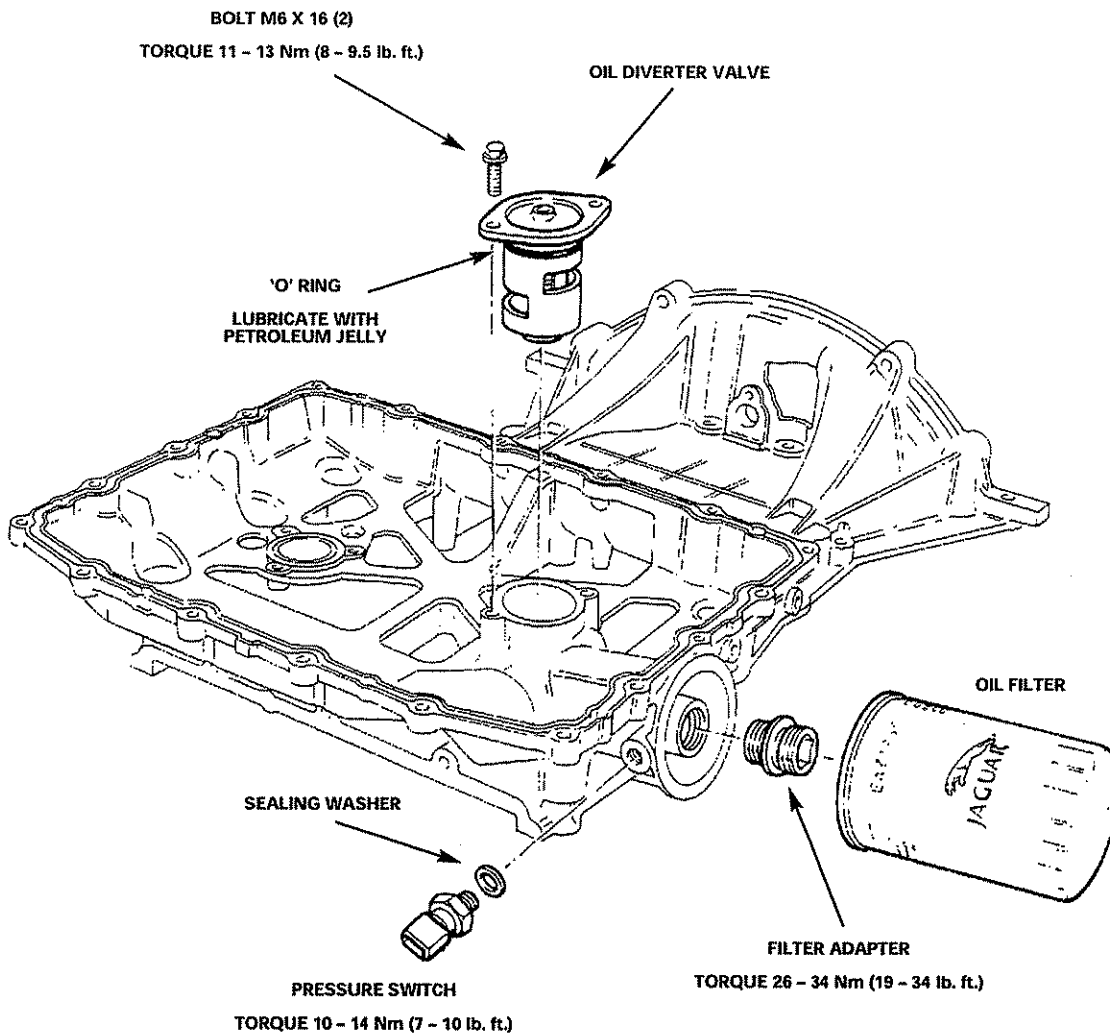
Structural Sump



AJV8 Engine Assembly

Structural Sump (continued)

STRUCTURAL SUMP WITH OIL COOLER (BOTTOM VIEW)



T180J2.17

NOTES

Structural sump sealant application

Structural sump and bed plate joints must be clean and free from oil.

Apply a continuous bead of Loctite Ultra Gray 5699 RTV sealant to the bed plate as shown on the illustration, with the diameter of the bead as indicated. No gaps are allowed in the sealant bead.

Within 20 minutes of initial sealant application, the structural sump must be installed and all bolts torqued.

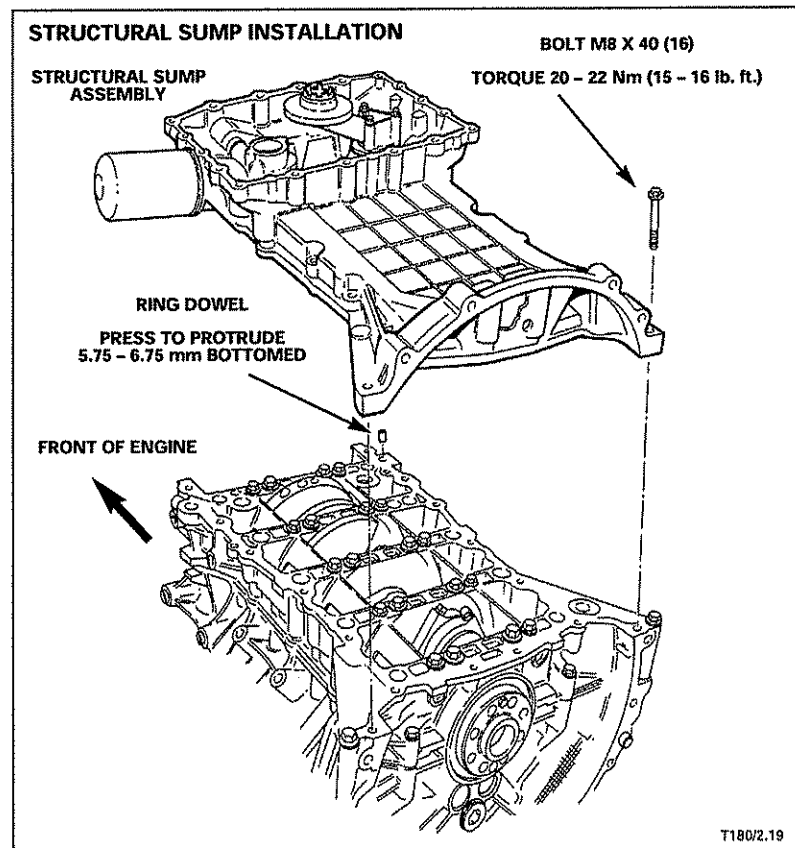
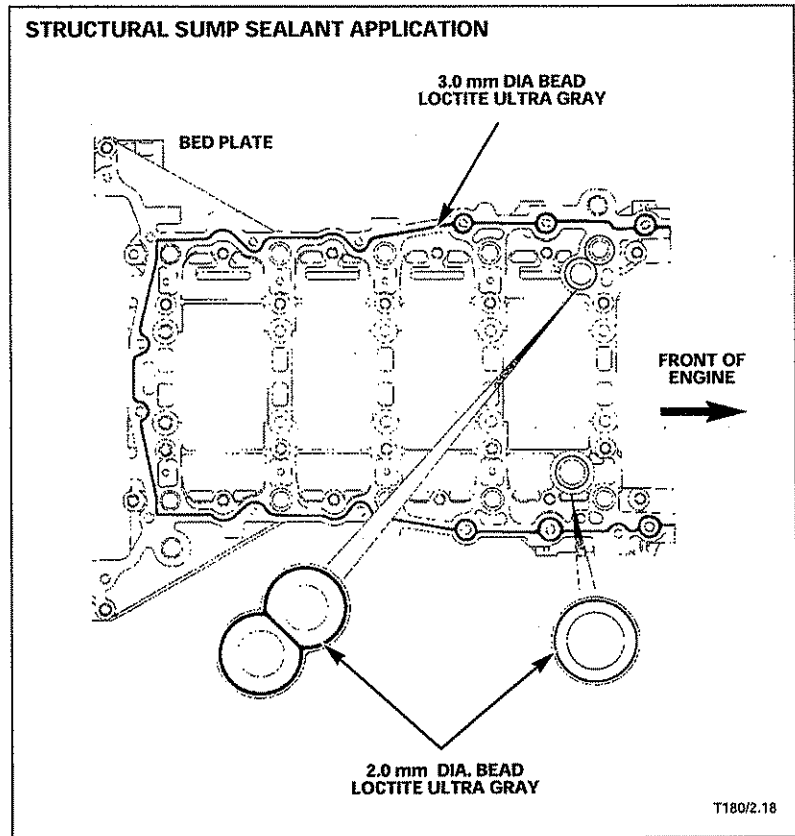
Remove any excess sealant from the joint and the block to timing case joint surface.

NOTE: If the operation is not completed within 20 minutes of initial sealant application, separate the structural sump from the bed plate. Clean the joints with a plastic or wooden scraper and repeat the procedure.

Structural Sump Installation

The transmission bell housing face of the installed structural sump may be from -0.2 mm to +0.1 mm flush with the cylinder block bell housing face.

NOTES



AJV8 Engine Assembly

Oil Pan

Oil Pan Installation

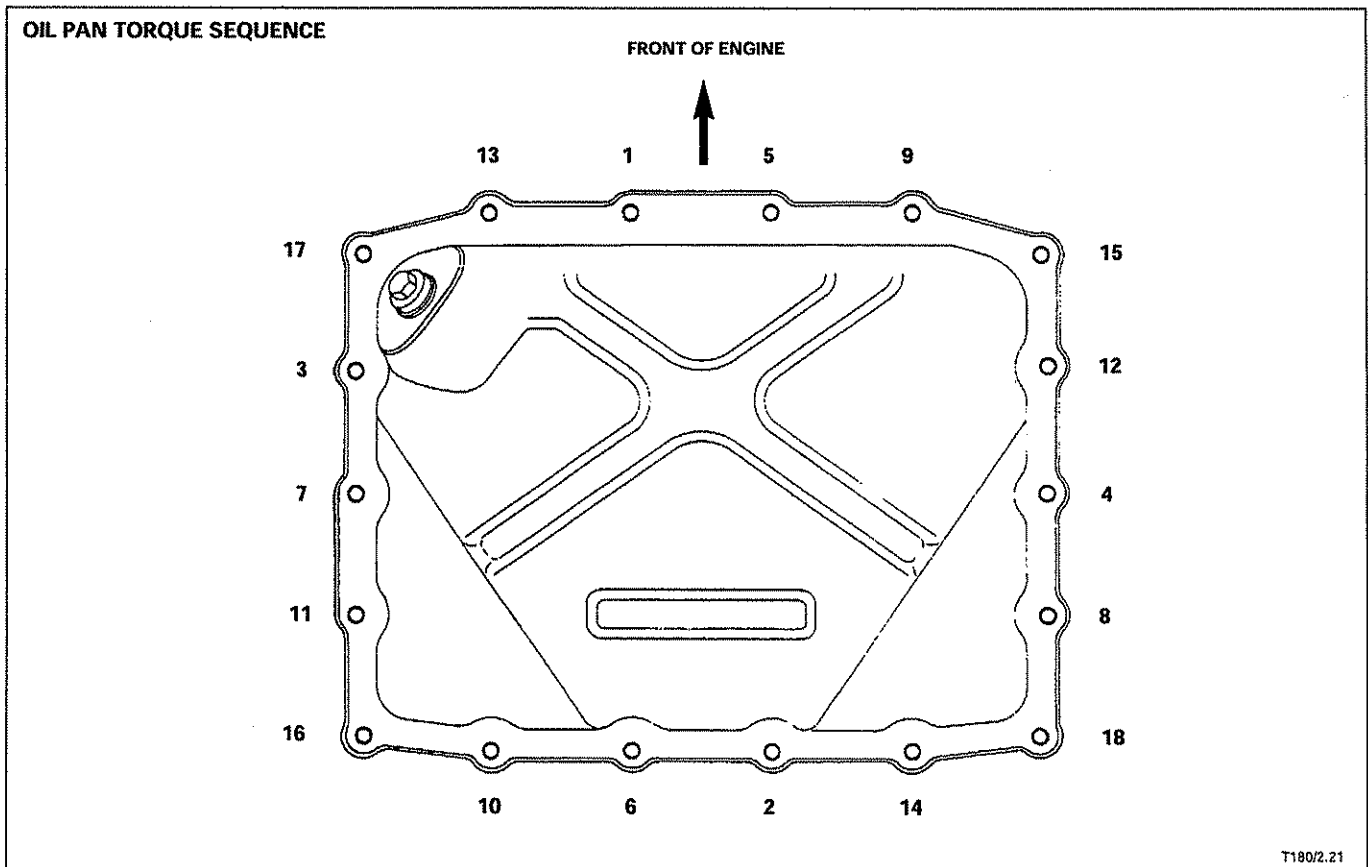
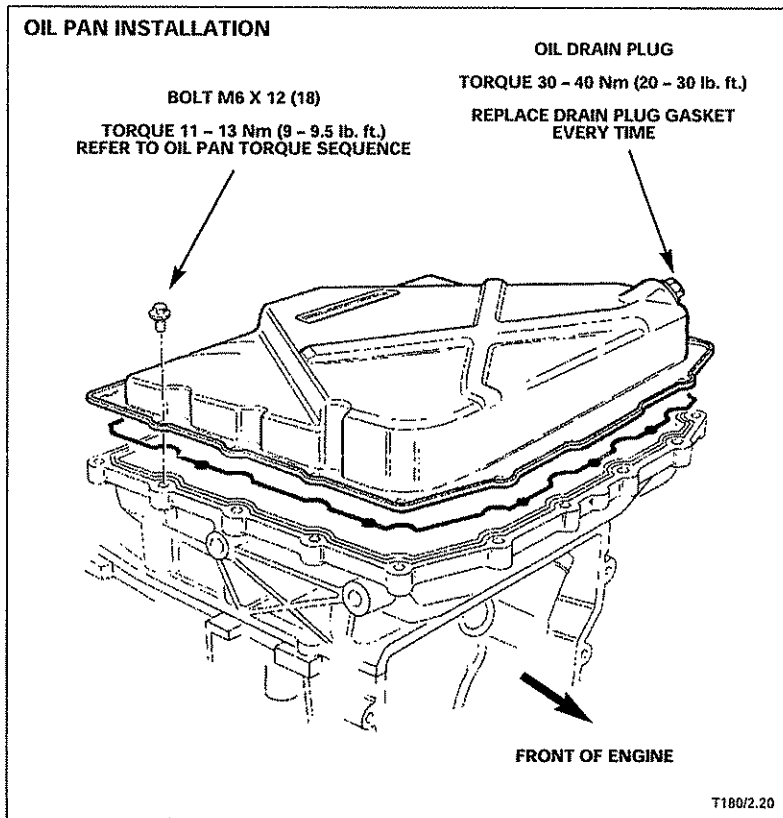
Fully seat the in-groove gasket in the structural sump.

Install all pan bolts finger tight.

Torque the bolts to 11 – 13 Nm following the sequence below.

NOTE: The oil drain plug gasket must be replaced whenever the plug is removed.

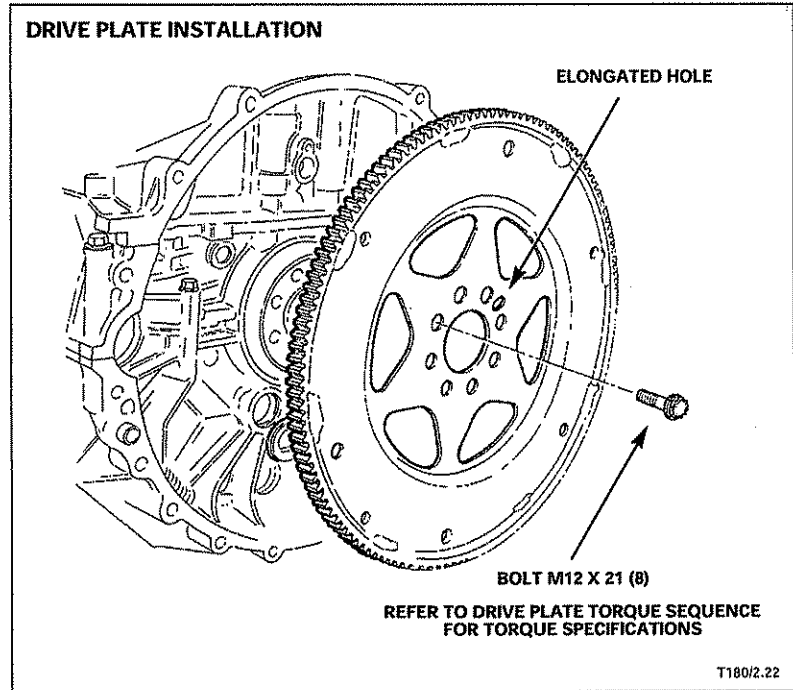
NOTES



Drive Plate

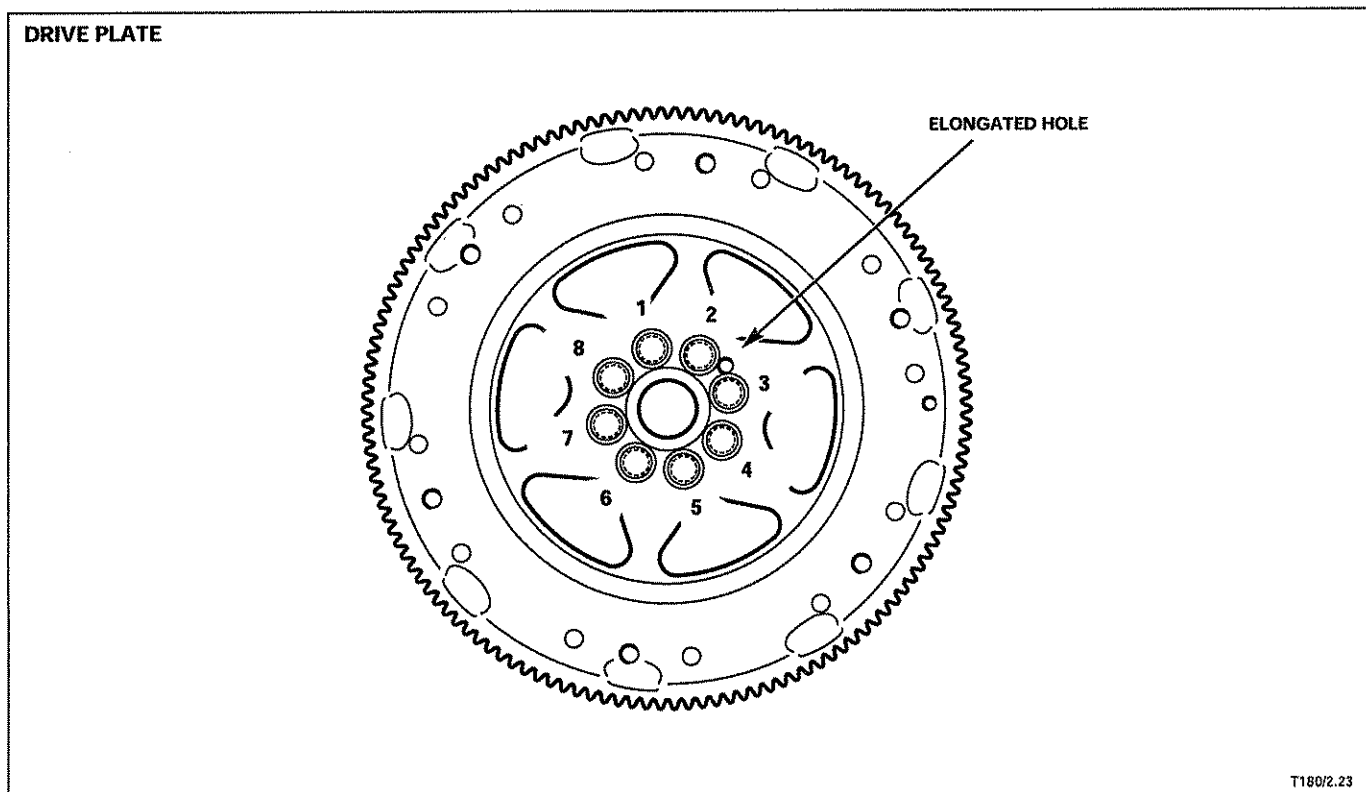
Drive Plate Installation

Install the drive plate with its elongated hole over the crankshaft dowel. The dowel must not protrude from the outer face of the drive plate. Install all bolts finger tight.



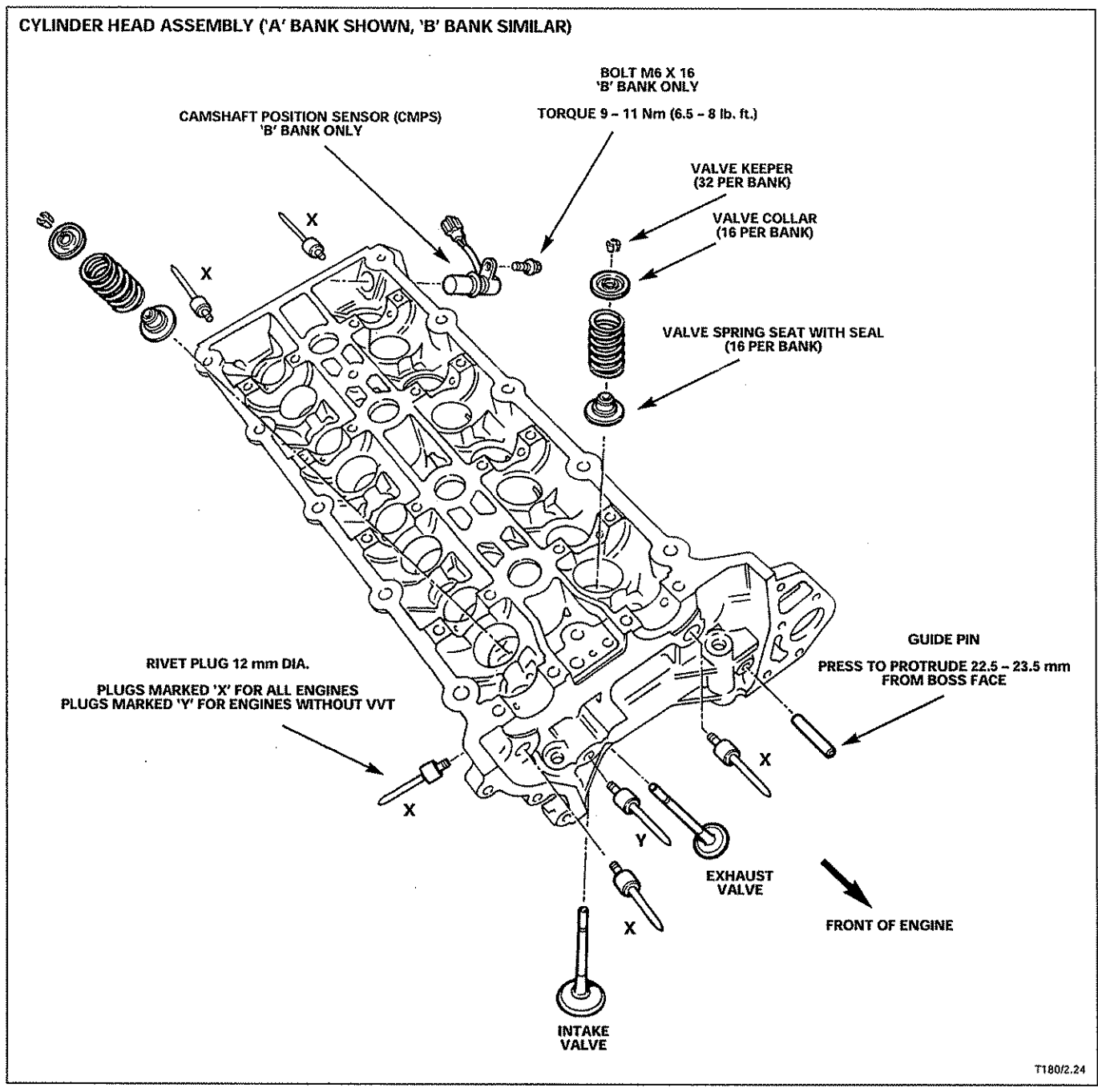
Drive plate bolt torque sequence

- Step 1 Torque bolts 1,3,5 & 7 to 14 – 16 Nm (10.5 – 12 lb ft).
- Step 2 Torque bolts 1,3,5 & 7 to 97 – 103 Nm (71.5 – 76 lb ft).
- Step 3 Torque bolts 2,4,6 & 8 to 14 – 16 Nm (10.5 – 12 lb ft).
- Step 4 Torques bolts 2,4,6 & 8 to 97 – 103 Nm (71.5 – 76 lb ft).



AJV8 Engine Assembly

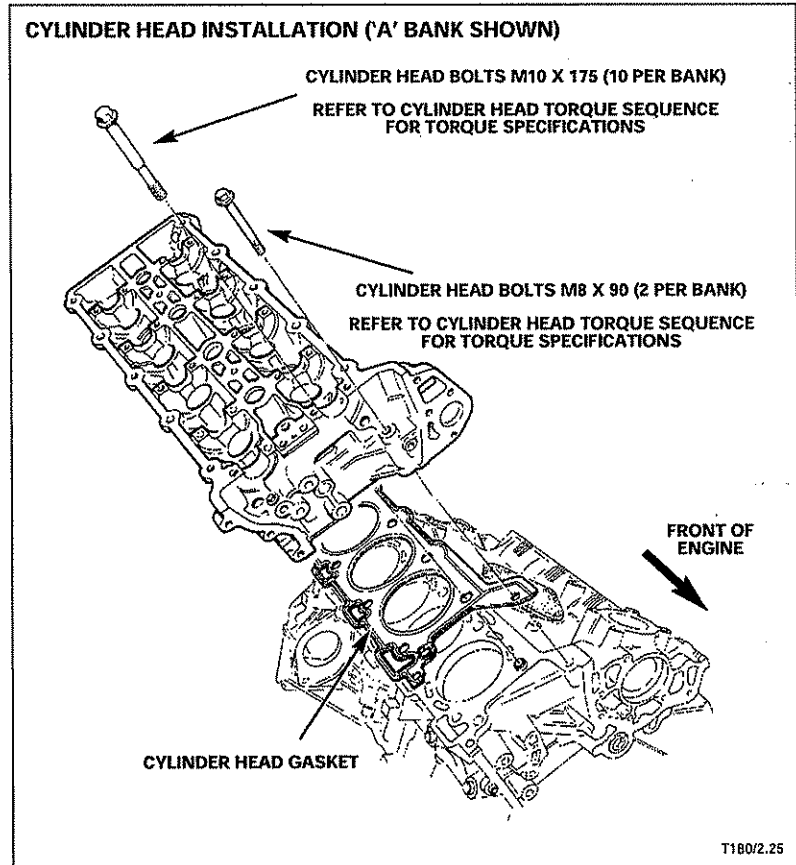
Cylinder Heads



NOTES

Cylinder Head Installation

Cylinder head, gasket mating surfaces, threaded holes, and gaskets must be clean and free from oil.



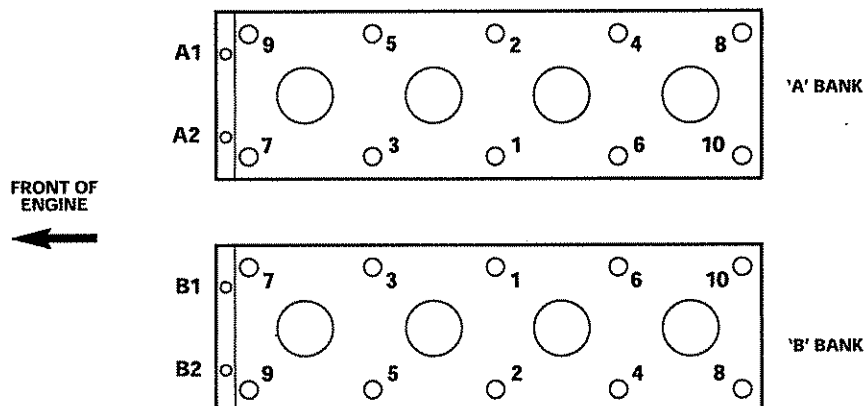
Cylinder head torque sequence

M10 – Bolts numbered 1 – 10 (use once only). Center punch bolt heads when fully torqued.

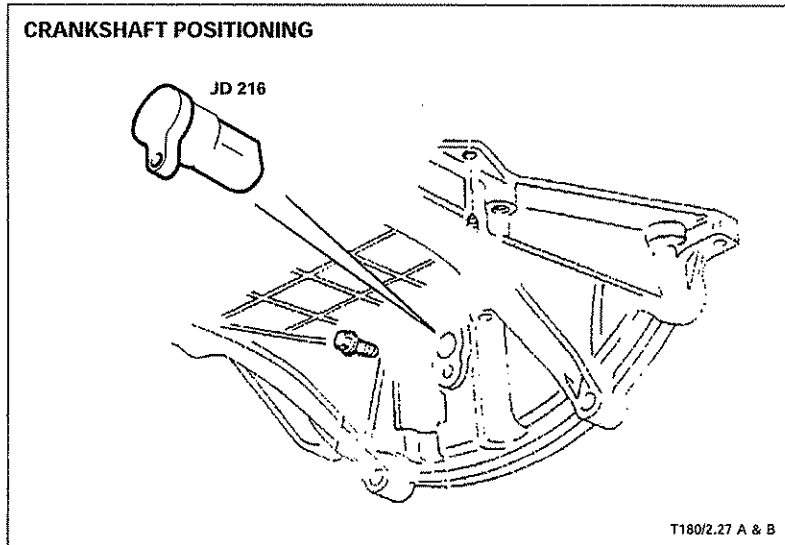
M8 – Bolts numbered A1 – B2.

- Step 1 Install all bolts hand tight
- Step 2 Torque M10 bolts to 20 Nm (15 lb ft)
- Step 3 Torque M10 bolts to 35 Nm (26 lb ft)
- Step 4 Tighten M10 bolts additional 90°
- Step 5 Tighten M10 bolts additional 90°
- Step 6 Torque M8 bolts to 23 – 27 Nm (17 – 20 lb ft)

CYLINDER HEAD TORQUE SEQUENCE



AJV8 Engine Assembly



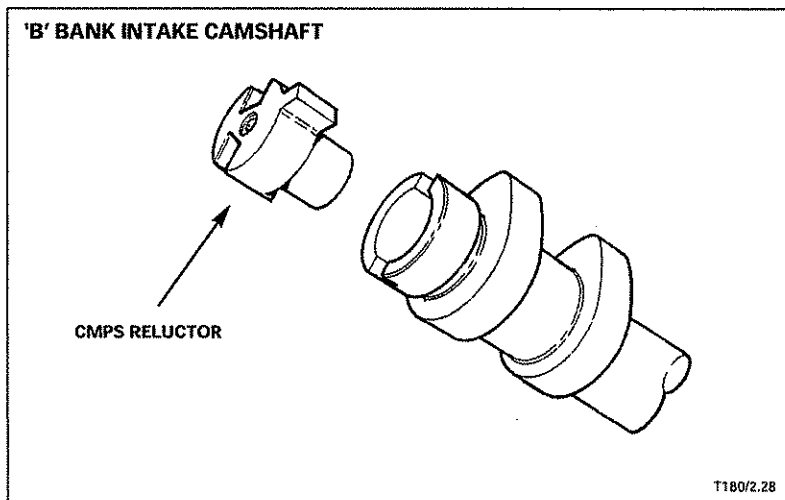
Camshafts

Prior to installing the camshafts, position the crankshaft to 45° ATDC cylinder 1A. Hold the drive plate in position with JD 216 inserted through the cylinder block crankshaft position sensor hole and engaged in the drive plate slot. Do not rotate the crankshaft until valve timing is complete.

CAUTION: Do not use JD 216 to lock the crankshaft when tightening camshaft, crankshaft or vibration damper bolts.

Camshaft position sensor

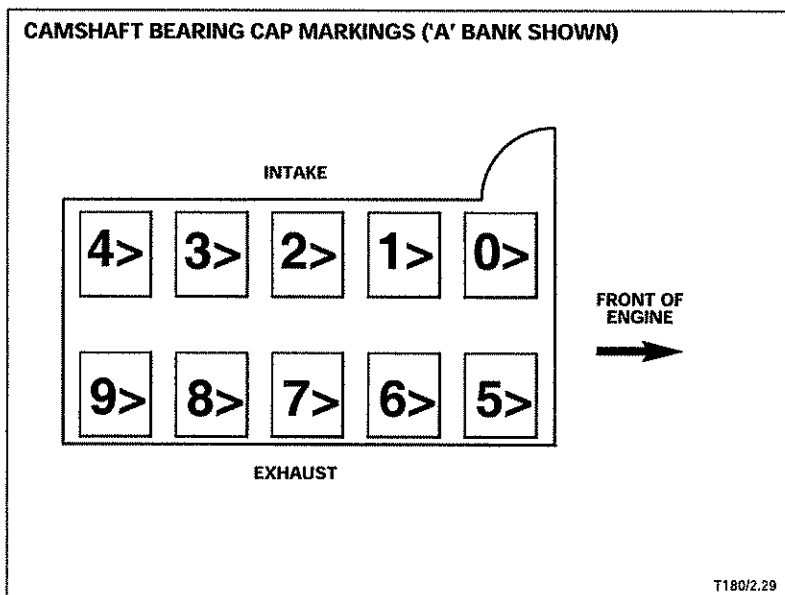
The camshaft position sensor retractor is pressed into the 'B' bank intake camshaft. There should be no noticeable gap between the engagement dogs on the retractor and the slots in the camshaft. Refer to Technical Bulletin 303-08.



Camshaft bearing caps

Camshaft bearing caps must be installed in their original positions as marked on their outer faces. The arrow mark (>) points toward the front of the engine. On 'A' bank bearing caps, the arrow appears after the number (1>); on 'B' bank bearing caps, the arrow appears before the number (>1).

Camshaft bearing caps	Numbers
Intake	0 – 4 from front
Exhaust	5 – 9 from front



NOTES

Lubricate the valve lifter bores and the valve stem heads with EP 90 oil. Install the valve lifters and adjusting shims in their original positions. Install the shims with the size marking facing down, towards the valve lifter.

Valve adjusting shims must be selected to give the following clearances:

Exhaust valve clearance

0.25 ± 0.02 mm (0.010 ± 0.0008 in.)

Inlet valve clearance

0.20 ± 0.02 mm (0.008 ± 0.0008 in.)

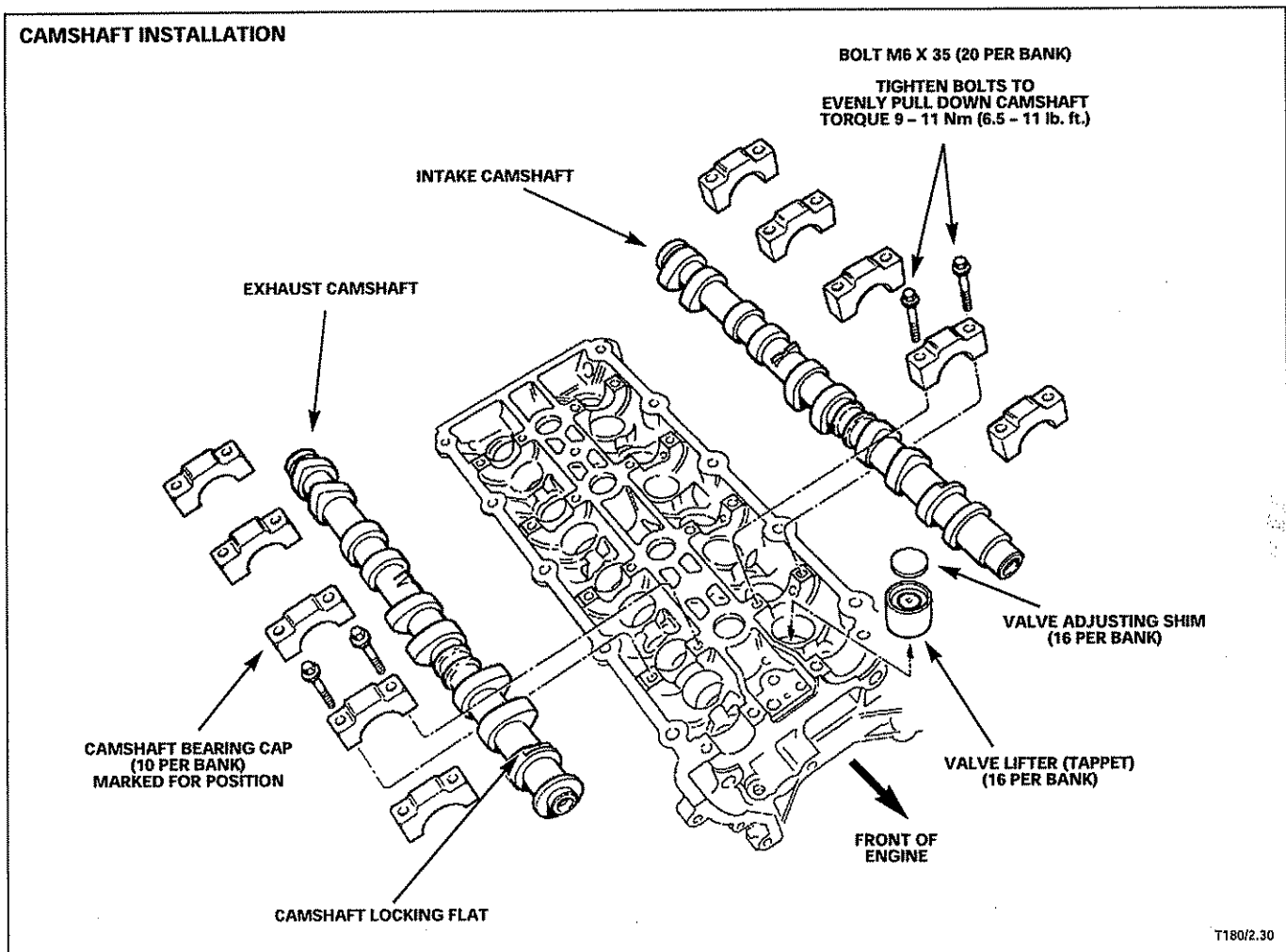
Lubricate the top of the adjusting shims and the camshaft lower bearings with engine oil.

Apply a drop of EP 90 oil to each camshaft lobe and install the camshafts with their locking flats parallel with the top face of the camshaft cover gasket surface.

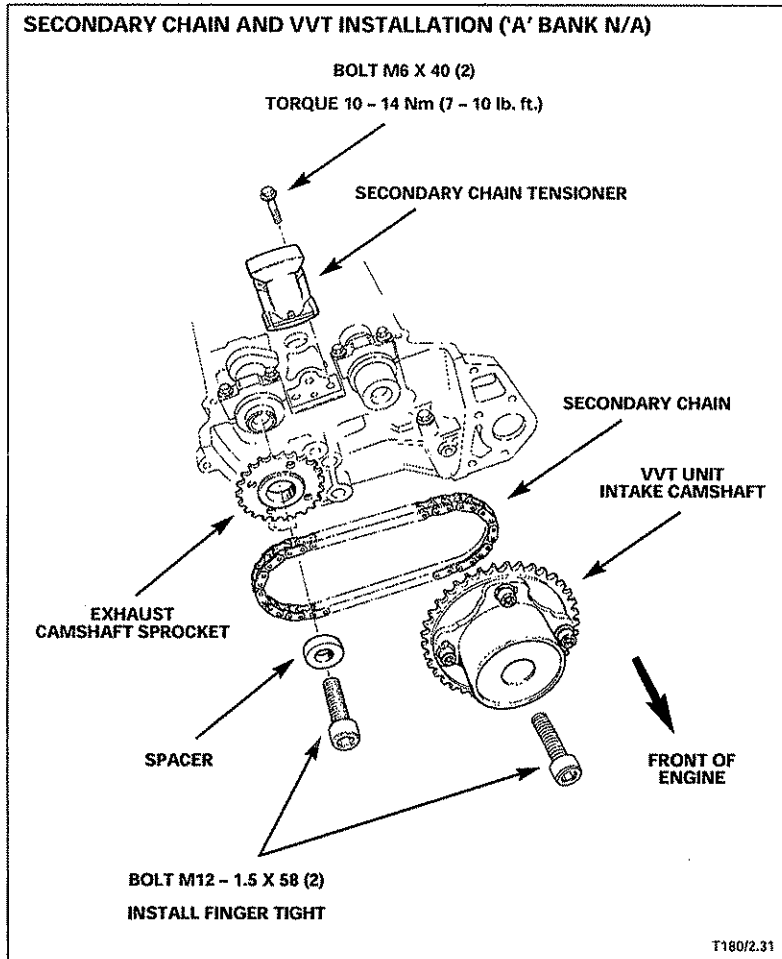
Apply a 4 mm drop of EP 90 oil to each camshaft bearing cap and position the caps according to their location markings. Refer to Camshaft Bearing Cap Markings, page 22.

Tighten the camshaft bearing caps in stages evenly. Torque to 9–11 Nm (6.5–8 lb ft).

Install a JD 215 camshaft locking bar across the cylinder head. Rotate each camshaft slightly until its locking flat is aligned with the locking bar.



Timing Chain and VVT Unit



Chain Tensioner and Guide Installation

Secondary tensioners

Insert a stiff piece of wire into the hole in the chain tensioner to release the check valve and collapse the tensioner. Install the tensioners as follows:

- 'A' bank secondary tensioner - hydraulic piston faces down.
- 'B' bank secondary tensioner - hydraulic piston faces up.

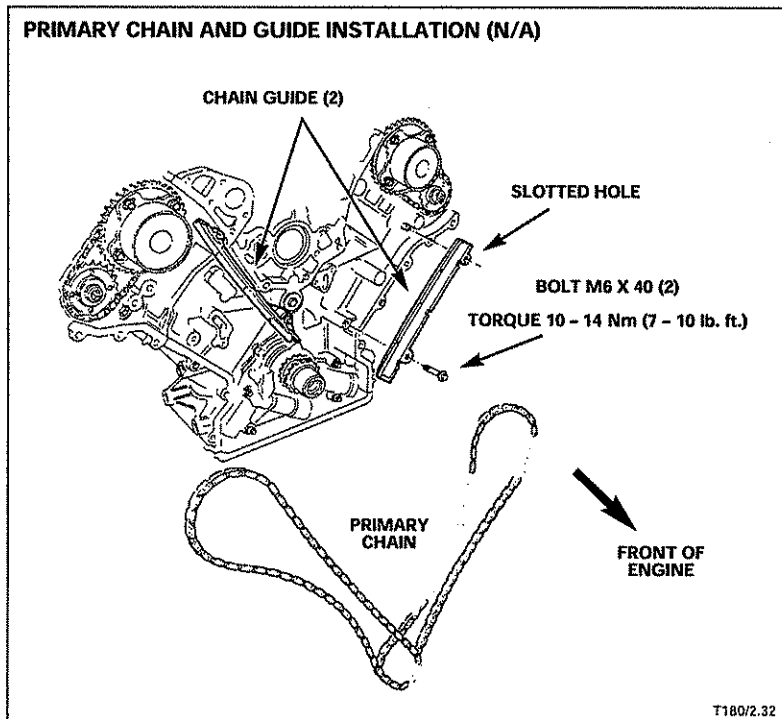
Primary chain tensioners and guides

Install the chain guides with the slotted hole up and the raised side toward the cylinder block. Install the primary chain tensioner blades. Insert a stiff piece of wire into the hole in the primary chain tensioners to release the check valve and collapse the tensioner. Install the tensioners and blanking plates as illustrated.

CAUTION: Blanking plates can be incorrectly installed. Incorrect installation reduces engine oil pressure to the tensioners.

NOTE: Supercharged AJV8 engines have flywheels in place of the VVT units.

NOTES



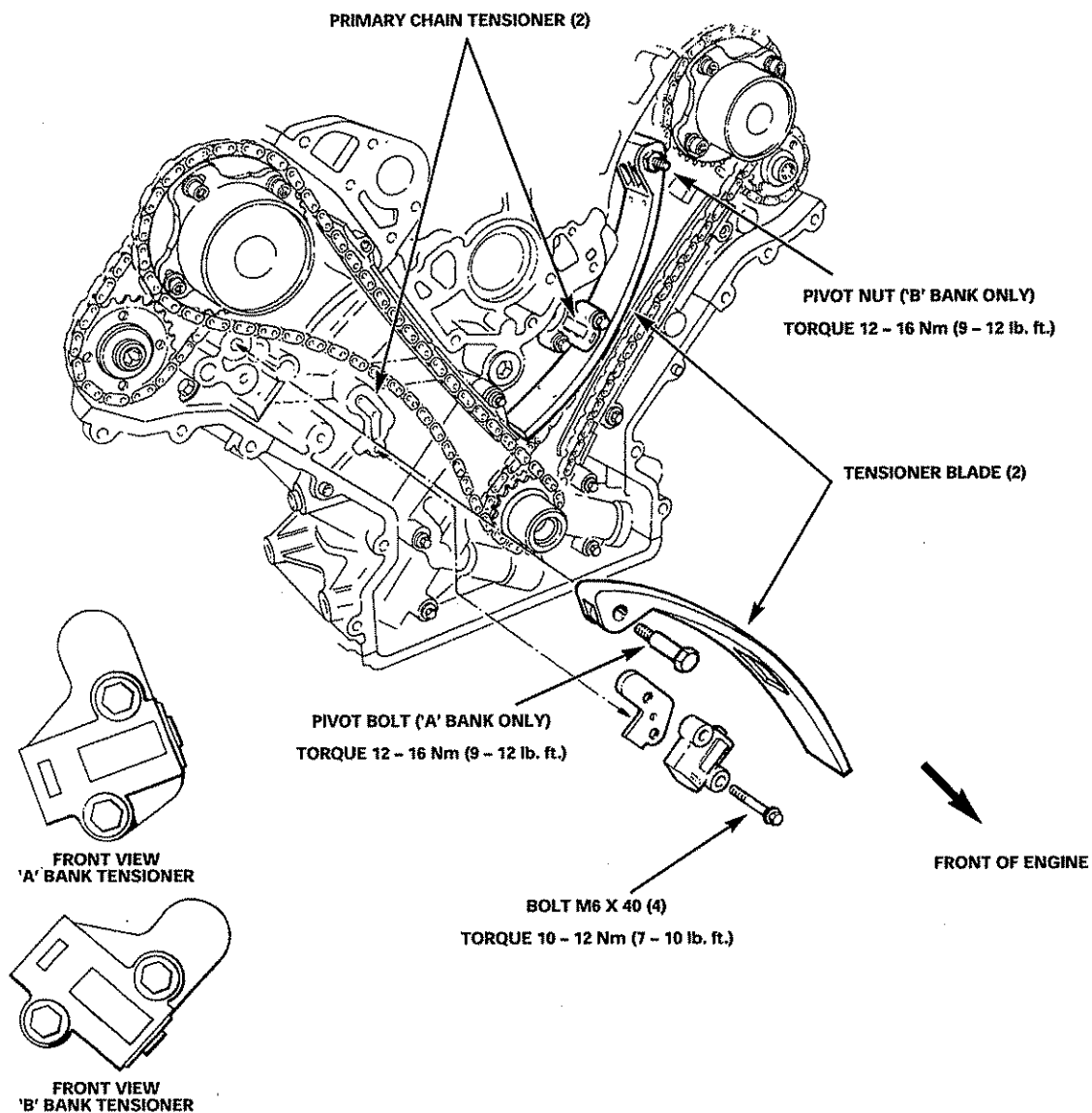
Chain Installation

Assemble the 'B' bank primary and secondary chain and sprocket assembly on the bench. Slide the assembly over the crankshaft and camshafts. The crankshaft key must engage in the sprocket and the chains should be positioned as illustrated. Install the camshaft sprocket bolts hand tight to allow the sprockets to rotate on the camshaft.

Repeat the procedure for the 'A' bank chains. The crankshaft sprockets must be positioned with their teeth out of phase. The tooth point of one sprocket should align with the valley of the other sprocket. If the alignment is incorrect, remove the 'A' bank sprocket, turn it over and reinstall.

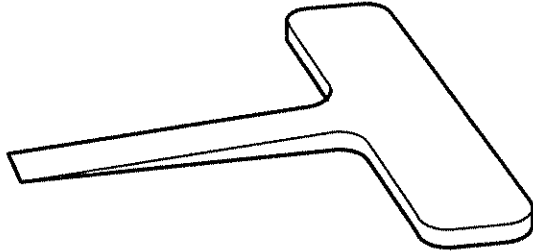
Install the 'A' bank chain and sprocket assembly. The camshaft sprocket bolts must be left loose to allow the sprocket to rotate on the camshaft.

PRIMARY CHAIN TENSIONER AND BLADE INSTALLATION



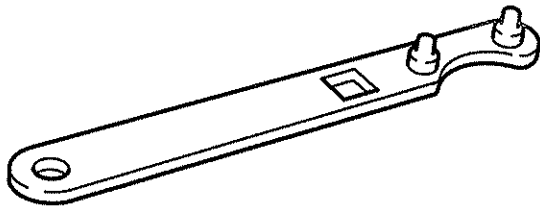
T180/2.33

JD 218 TIMING CHAIN TENSIONER WEDGE



T180/2.34

JD 217 TIMING CHAIN TENSIONER TOOL



T180/2.35

Camshaft Timing

Check that the crankshaft is positioned to 45° ATDC with a JD 216 drive plate locking pin installed.

Using a JD 215 camshaft locking bar, check that the camshafts are held with their flats up and parallel with the top face of the cylinder head.

Check that the VVT units are fully retarded.

Tighten the 'B' bank primary chain by inserting 1 or 2 JD 218 timing chain tensioning wedges between the 'B' bank primary chain tensioner and the tensioner blade.

Fit the JD 217 timing chain tensioner tool to the 'B' bank exhaust sprocket and apply 10 – 15 Nm (7 – 11 lb ft) counter clockwise torque to the exhaust camshaft sprocket while torquing the exhaust camshaft sprocket bolt to 110 – 130 Nm (81 – 96 lb ft). Continue to hold the tension and torque the intake camshaft sprocket bolt to 110 – 130 Nm (81 – 96 lb ft).

Repeat the procedure for the 'A' bank chains.

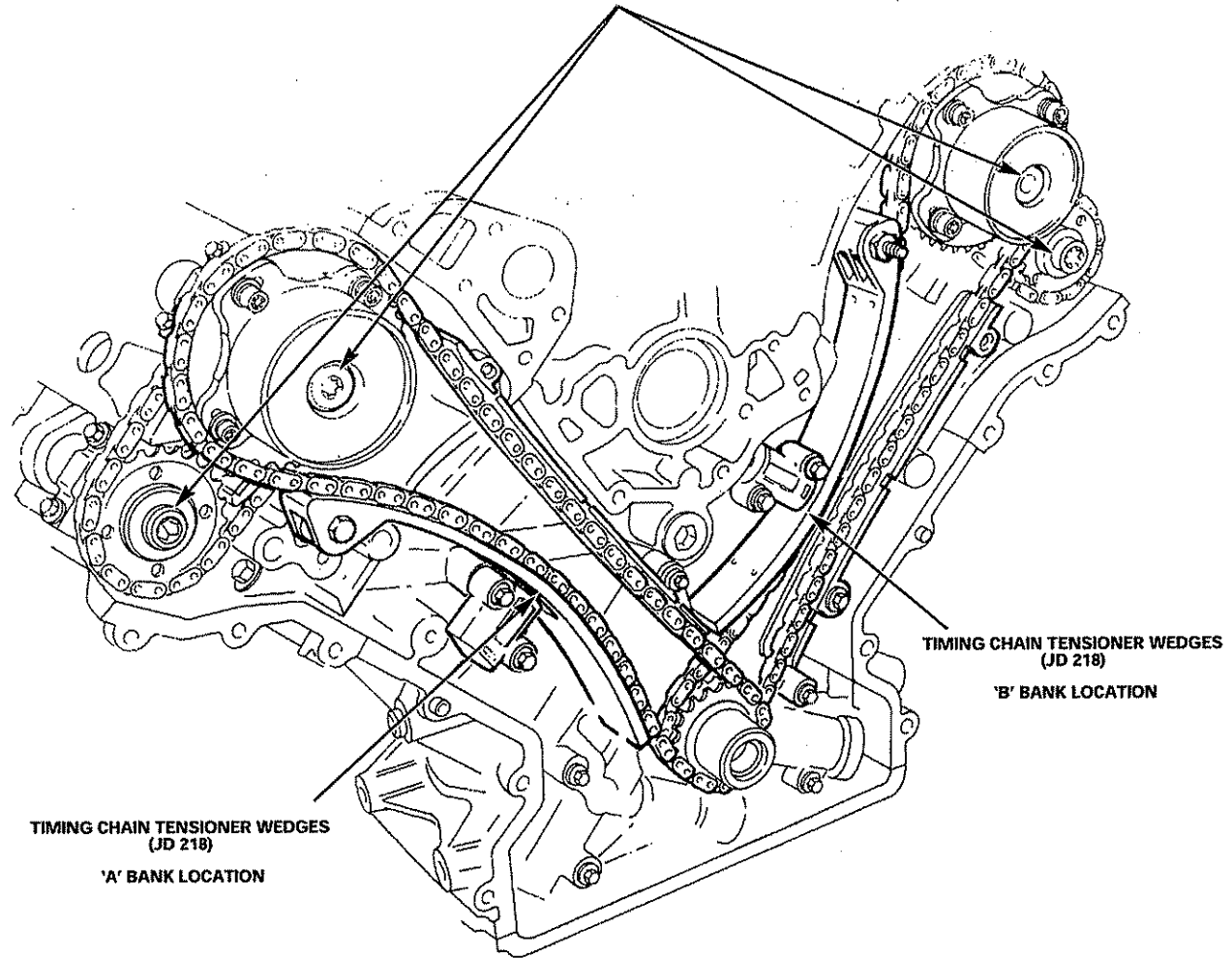
Remove the JD 216 locking pin from the drive plate, the JD 215 camshaft locking bars and the JD 218 timing chain tensioning wedges.

NOTES

CAMSHAFT SPROCKET TIGHTENING PROCEDURE

EXHAUST CAMSHAFT SPROCKETS:
APPLY AND HOLD 10 - 15 Nm (7 - 11 lb. ft.) TORQUE TO THE LEFT WITH JD 217

TORQUE 110 - 130 Nm (81 - 96 lb. ft.)



T180/2.36

NOTES

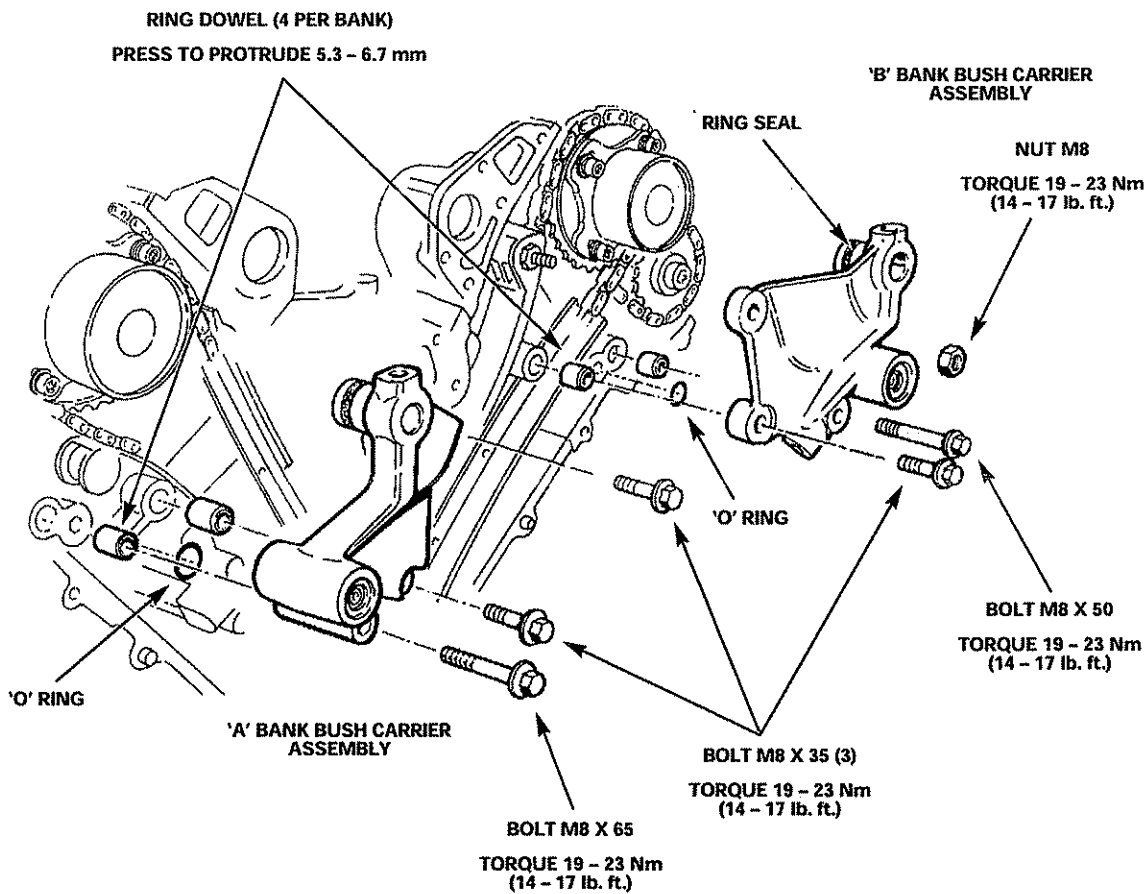
AJV8 Engine Assembly

Bush Carriers

Use petroleum jelly to hold the 'O' rings in the bush carrier recesses during installation.

Insert the bush into the VVT unit, compressing the ring seal with fingers as required. Locate the bush carrier onto the dowels and fully seat by hand before fitting bolts.

BUSH CARRIER INSTALLATION (N/A ONLY)



T180/2.37

NOTES

Timing Cover

Insert and fully seat the timing cover in-groove gaskets in the cover.

Apply a 12 mm long, 3 mm diameter bead of Loctite Ultra Gray 5699 RTV sealant to the cylinder block assembly joints marked X. The cover must be installed and torqued within 20 minutes of initial sealant application.

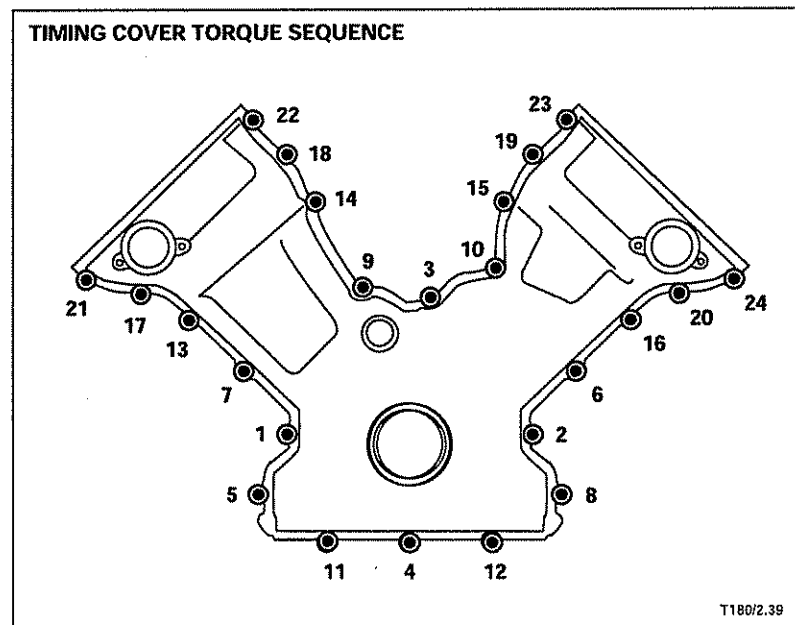
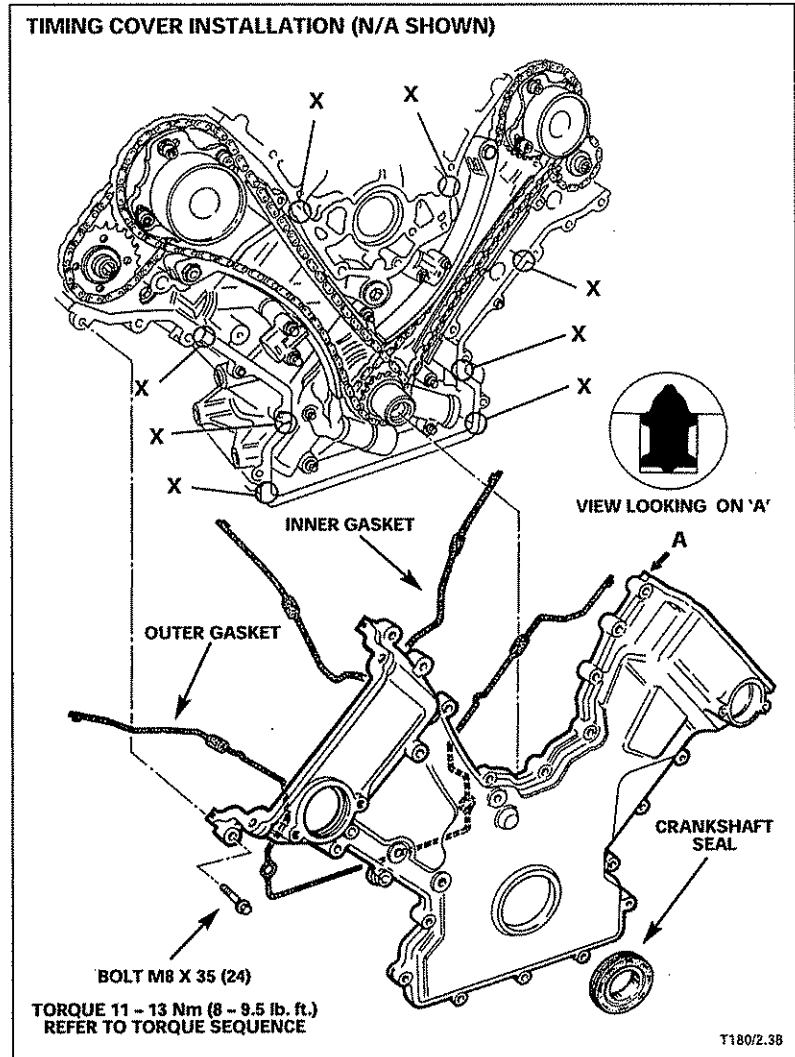
Locate the timing cover on its dowels and install so that the sealant and in-groove gaskets are not smeared.

Install the bolts and torque to 11 - 13 Nm (8 - 9.5 lb ft) following the torque sequence.

Front crankshaft seal installation

Install the front seal with JD 235. Maintain the insertion load for 3 - 5 seconds. The seal must be parallel to the front face of the crankshaft within 0.3 mm.

NOTES



Crankshaft Vibration Damper and VVT Solenoids

NOTE: The crankshaft vibration damper bolt has a locking patch and must not be reused. If the bolt is removed, clean the threads in the crankshaft with a M16 x 2 – 6H plug tap and replace the bolt.

Up to engine No. 961216XXXX: vibration damper without locking cone

Refer to Service Bulletin 303-05.

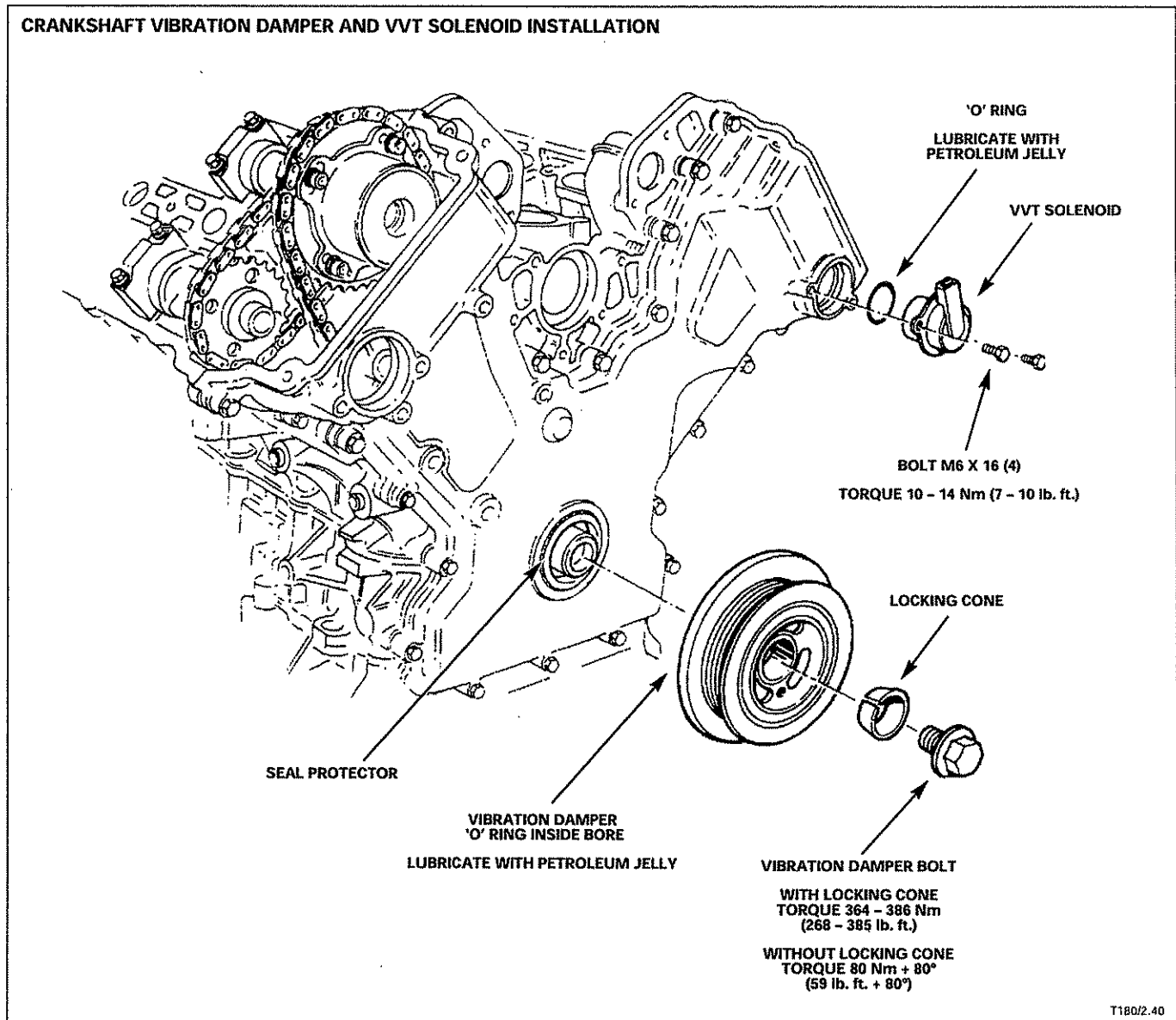
From engine No. 961217XXXX: vibration damper with locking cone

Remove the front seal protector.

Lubricate the 'O' ring and install in the damper bore..

Install the damper and center bolt. Install the 18G-1437 crankshaft locking tool with the 18G-14372 adapter to the damper.

Torque the center bolt to 364 – 386 Nm (268 – 385 lb ft).



Valve Adjustment

Rotate the engine with the crankshaft damper bolt at least 3 revolutions in the normal direction of rotation. Install a JD 216 drive plate locking pin to position the crankshaft at 45° ATDC and recheck the camshaft timing using a JD 215 locking bar to be sure that the camshaft flats are parallel with the top face of the cylinder heads. Remove the JD 215 and check/adjust the valves as described below.

Checking valve adjustment

Engine must be COLD.

- 1 Remove on-plug coils, note harness connections, and camshaft covers.
- 2 Rotate crankshaft in normal engine direction of rotation only with crankshaft vibration damper bolt (24 mm).
- 3 Measure and record all the existing valve clearances.
- 4 Calculate required shims.

Adjusting valves

- 1 Fit the base plate of adjusting tool JD 232 to the cylinder head using bolts supplied.
NOTE: If adjusting intake valves, slide tool fully down for max. clearance. Slide fully up for exhaust valve.
- 2 Rotate the crankshaft to position the required valves so that there is maximum clearance between camshaft and shim.
- 3 Set the fingers of adapter to the fully unscrewed position using knurled bolts.
- 4 Fit adapter to base plate adjacent to the valves which require adjustment.
- 5 Tighten the winged bolts.
- 6 Position the fingers onto the outer edges of the valve lifter. Each finger must locate on the edge of the lifter.
- 7 Tighten the knurled bolts to compress the valve springs, until a firm resistance is felt.
- 8 The tool fingers must touch the lifter only, leaving the shim clear.
- 9 Remove excess oil on the lifter and shim.

 **WARNING: THE FOLLOWING OPERATIONS REQUIRE THE USE OF COMPRESSED AIR. ALWAYS WEAR EYE PROTECTION.**

- 10 Surround the immediate working area with a clean rag to contain any loose objects and shims displaced by the compressed air.
- 11 Aim the fan nozzle air gun, JD 233, at the edge of the shim and blow the shim from the lifter.
- 12 Clean and measure the thickness of the shim.
- 13 Calculate the shim required to correct the valve clearance.
- 14 Lubricate the selected shim with engine oil and install with the size marking facing the lifter.
- 15 Loosen the knurled screws on JD 232 attachment to allow the valve springs to return to their normal position.
- 16 When all valves have been adjusted, rotate the engine three times to settle all the valves in.
- 17 Recheck the valve clearances, adjust as required.

AJV8 Engine Assembly

Valve Adjustment (continued)

Valve adjusting shims

Thickness:	mm	(in.)	Part Number
	2.18	(0.0858)	NCA 2542DA 1
	2.20	(0.0866)	NCA 2542DA 2
	2.22	(0.0874)	NCA 2542DA 3
	2.24	(0.0882)	NCA 2542DA 4
	2.26	(0.0890)	NCA 2542DA 5
	2.28	(0.0898)	NCA 2542DA 6
	2.30	(0.0906)	NCA 2542DA 7
	2.32	(0.0913)	NCA 2542DA 8
	2.34	(0.0921)	NCA 2542DA 9
	2.36	(0.0929)	NCA 2542DA 10
	2.38	(0.0937)	NCA 2542DA 11
	2.40	(0.0945)	NCA 2542DA 12
	2.42	(0.0953)	NCA 2542DA 13
	2.44	(0.0961)	NCA 2542DA 14
	2.46	(0.0969)	NCA 2542DA 15
	2.48	(0.0976)	NCA 2542DA 16
	2.50	(0.0984)	NCA 2542EA 1
	2.52	(0.0992)	NCA 2542EA 2
	2.54	(0.1000)	NCA 2542EA 3
	2.56	(0.1008)	NCA 2542EA 4
	2.58	(0.1016)	NCA 2542EA 5
	2.60	(0.1024)	NCA 2542EA 6
	2.62	(0.1031)	NCA 2542EA 7
	2.64	(0.1039)	NCA 2542EA 8
	2.66	(0.1047)	NCA 2542EA 9
	2.68	(0.1055)	NCA 2542EA 10
	2.70	(0.1063)	NCA 2542EA 11
	2.72	(0.1071)	NCA 2542EA 12
	2.74	(0.1079)	NCA 2542EA 13
	2.76	(0.1087)	NCA 2542EA 14
	2.78	(0.1094)	NCA 2542EA 15
	2.80	(0.1102)	NCA 2542EA 16
	2.82	(0.1110)	NCA 2542FA 1
	2.84	(0.1118)	NCA 2542FA 2
	2.86	(0.1126)	NCA 2542FA 3
	2.88	(0.1134)	NCA 2542FA 4
	2.90	(0.1142)	NCA 2542FA 5

Camshaft Covers

Camshaft Cover Installation

Insert and fully seat the camshaft cover and spark plug in-groove gaskets in the cover.

Replace the camshaft cover bolt seals.

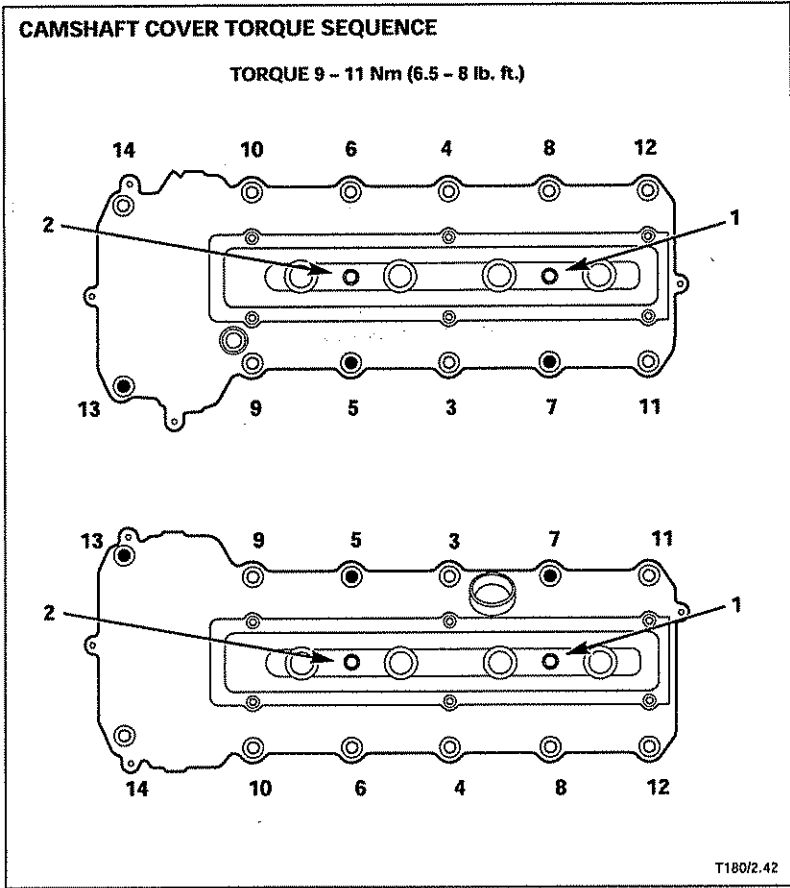
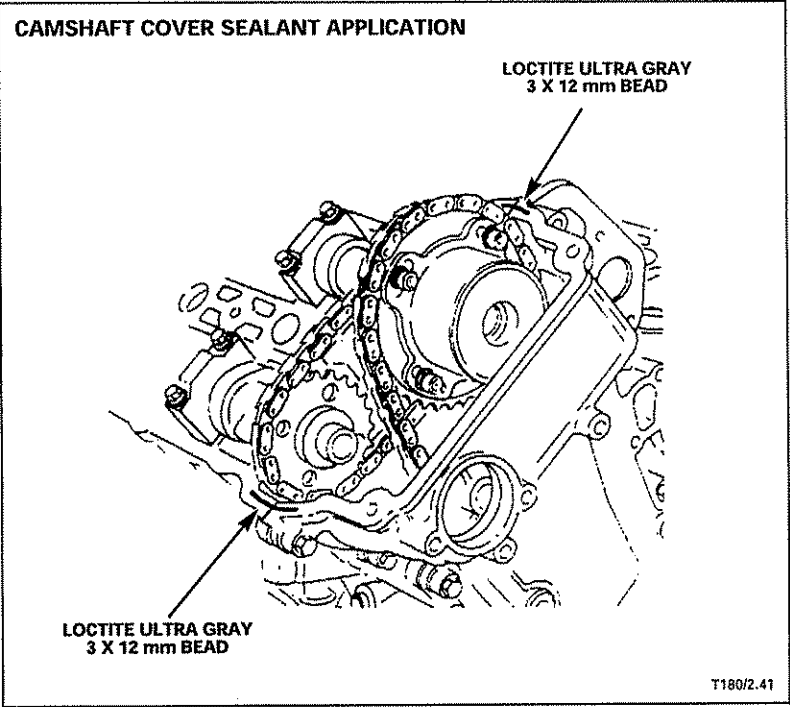
Apply a 12 mm long, 3 mm diameter bead of Loctite Ultra Gray 5699 RTV sealant to the areas indicated.

Install the cover. Avoid smearing the sealant.

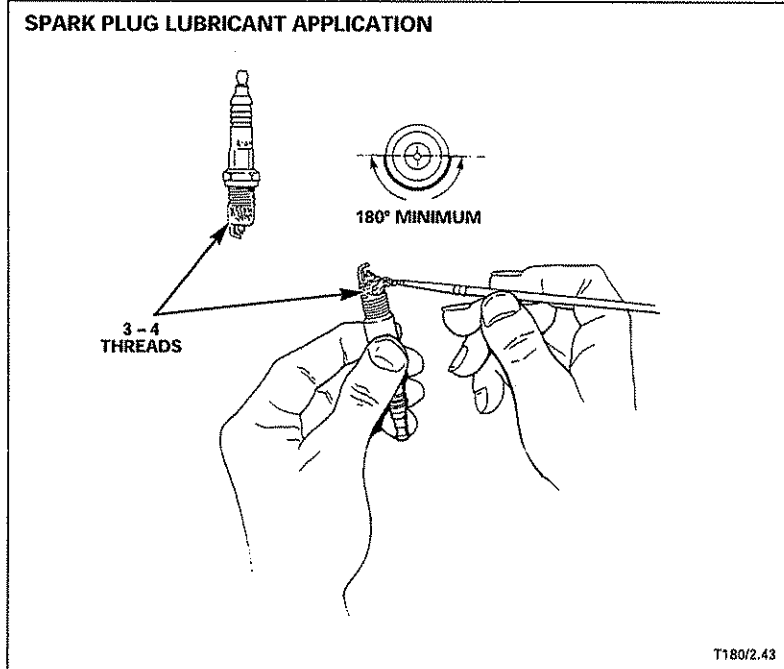
Finger tighten all of the cover bolts and torque to 9 – 11 Nm (6.5 – 8 lb ft) within 20 minutes. Follow the torque sequence shown in the illustration.

NOTE: Bolts 5, 7, and 13 have posts to attach the engine cover.

NOTES



Spark Plugs and Ignition Coils



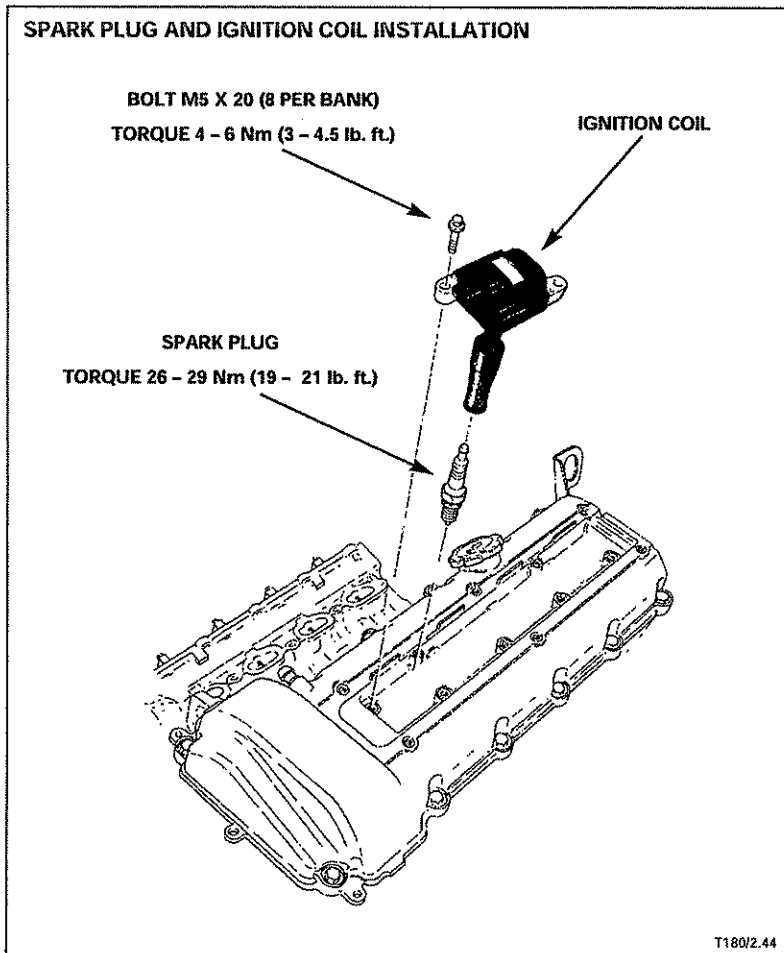
Spark Plug Installation

Apply 'Neverseel' to the 3 - 4 threads next to the spark plug electrodes. Fill to full thread depth for 180° of thread circumference.

⚠ CAUTION: Do not contaminate the spark plug electrodes.

Torque spark plugs to 25 - 29 Nm (18.5 - 21 lb ft).

NOTES



Cooling System

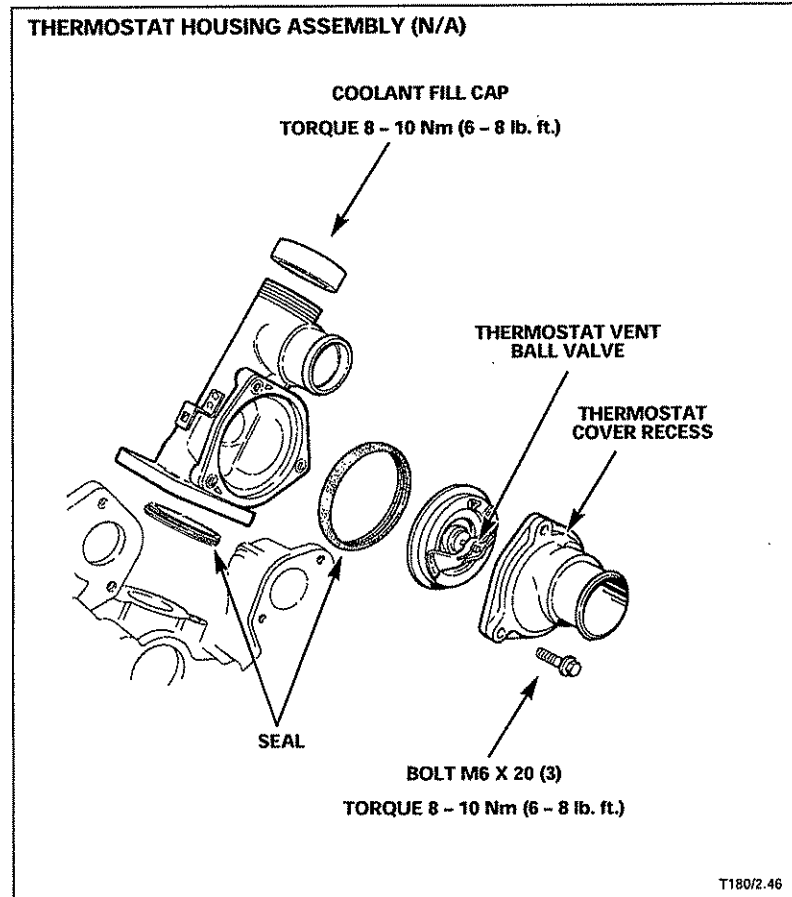
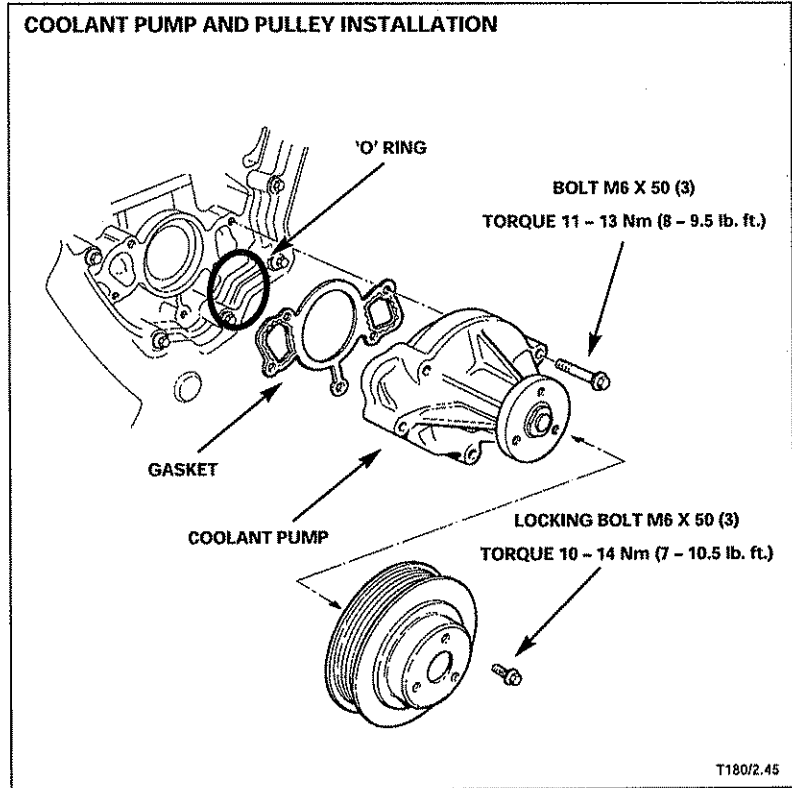
Coolant Pump and Pulley Installation

Lubricate the coolant pump 'O' ring with petroleum jelly. Install the coolant pump gasket dry.

N/A Thermostat Housing Installation

The thermostat seal may be fitted either way. The thermostat vent ball valve must locate in the cover recess. Lubricate the seals with recommended antifreeze or water only.

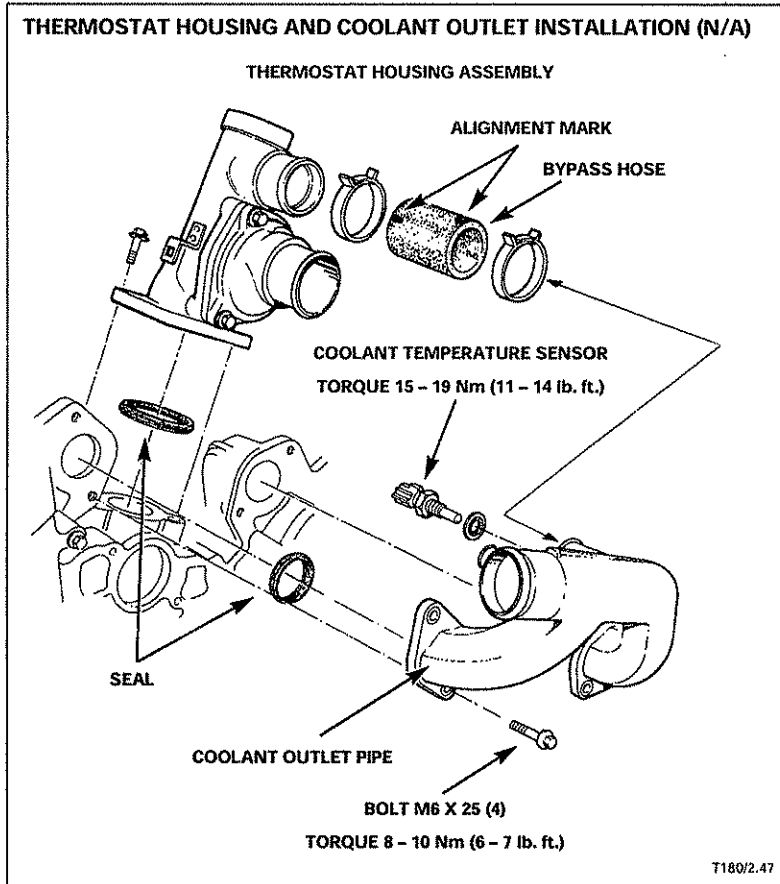
NOTES



Cooling System (continued)

Thermostat Housing and Coolant Outlet Pipe Installation

Use only water or recommended antifreeze to lubricate cooling system seals and hoses.



Install the bypass hose to the thermostat housing with the hose alignment marks facing up.

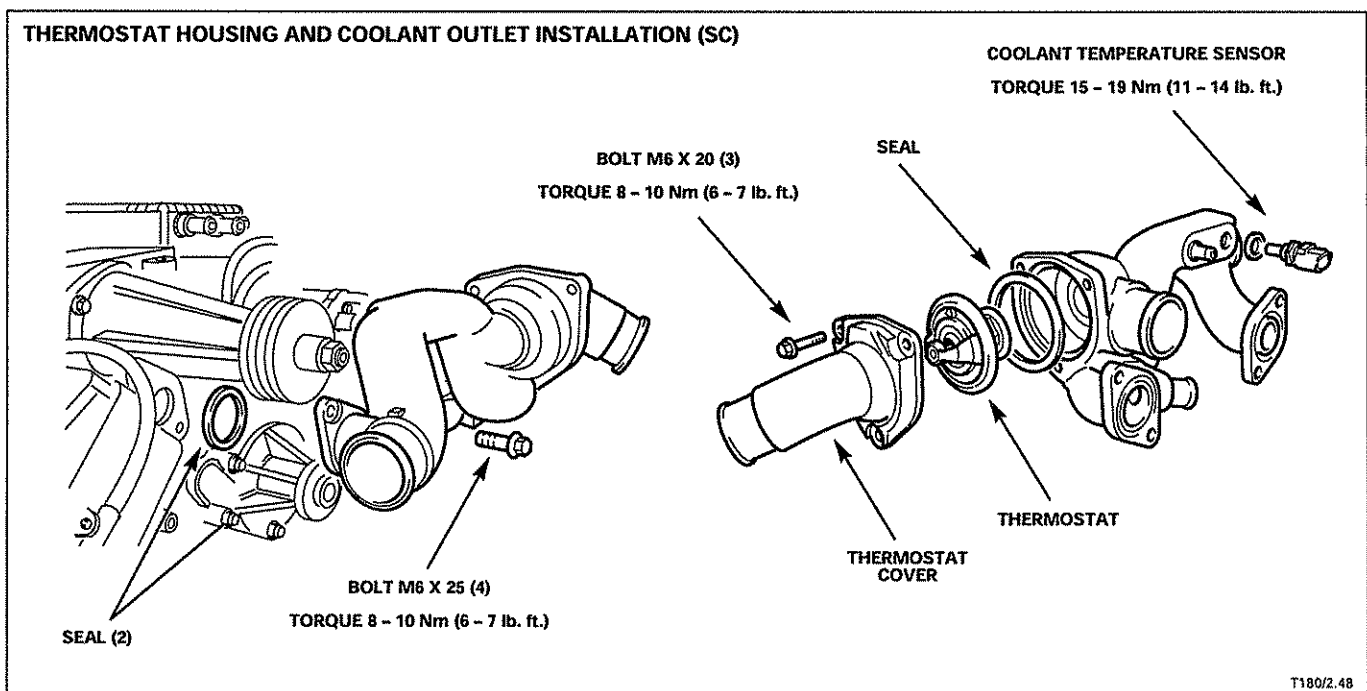
Install both bypass hose clamps. Position the thermostat housing clamp over the alignment mark. Position the coolant outlet pipe clamp in the middle of the hose.

Install the thermostat housing to the block.

Slide the coolant outlet pipe into the bypass hose and install to the cylinder heads.

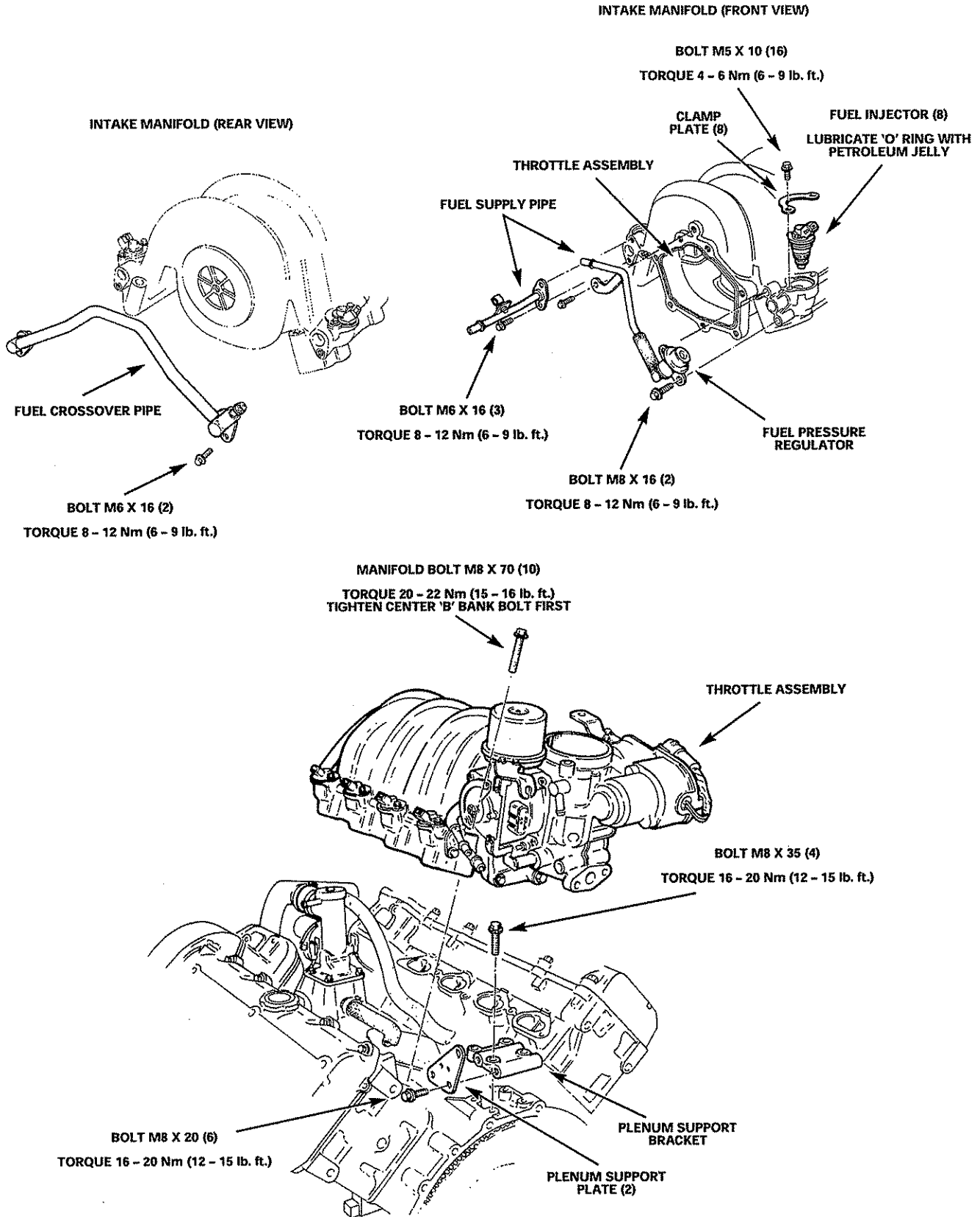
Position the hose clamp over the alignment mark.

NOTES



Intake Manifold: Normally Aspirated

INTAKE MANIFOLD INSTALLATION

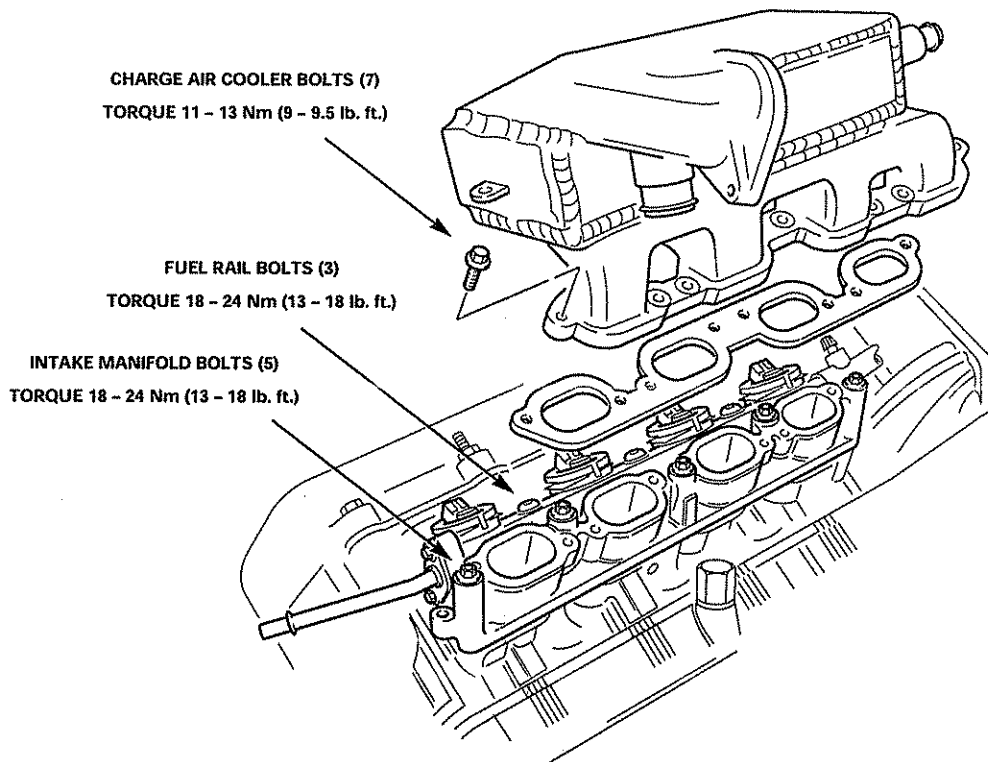


T180/2.49 A, B & C

AJV8 Engine Assembly

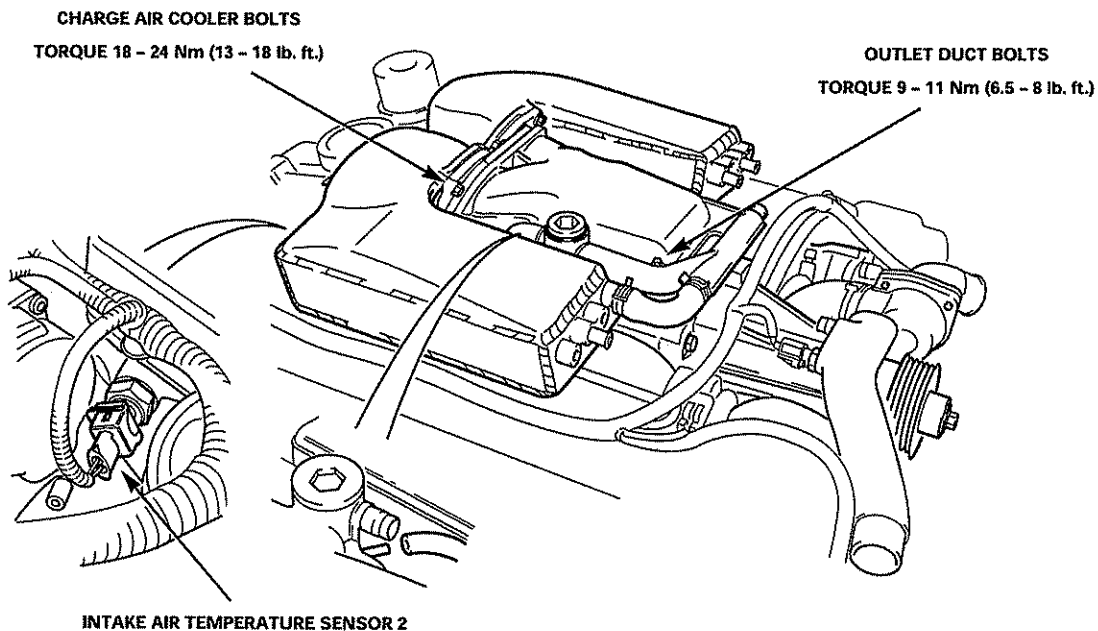
Intake Manifold: Supercharged

CHARGE AIR COOLER INSTALLATION



T180/2.50

OUTLET DUCT INSTALLATION



T180/2.51

Exhaust Manifolds

Tighten bolts following the torque sequence.

Bolts have a locking patch and must not be reused. If the manifold is removed, clean the manifold bolt hole threads using an M8 x 1.25 plug tap.

EXHAUST MANIFOLD INSTALLATION ('A' BANK SHOWN, 'B' BANK SIMILAR)

EXHAUST MANIFOLD

CYLINDER HEAD

BOLTS M8 X 65 (8):
USE ONLY GRADE 10.9 BOLTS
TORQUE 16 - 20 Nm (12 - 15 lb. ft.)
REFER TO TORQUE SEQUENCE

EXHAUST MANIFOLD
GASKET

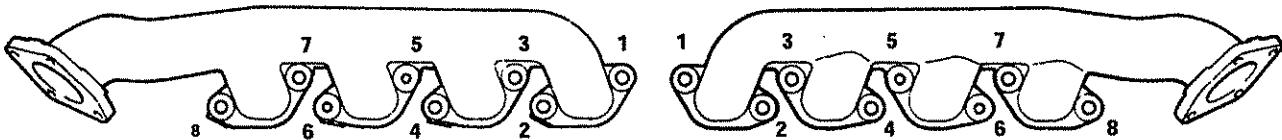
SPACER (8)

T180/2.52

EXHAUST MANIFOLD TORQUE SEQUENCE

'A' BANK

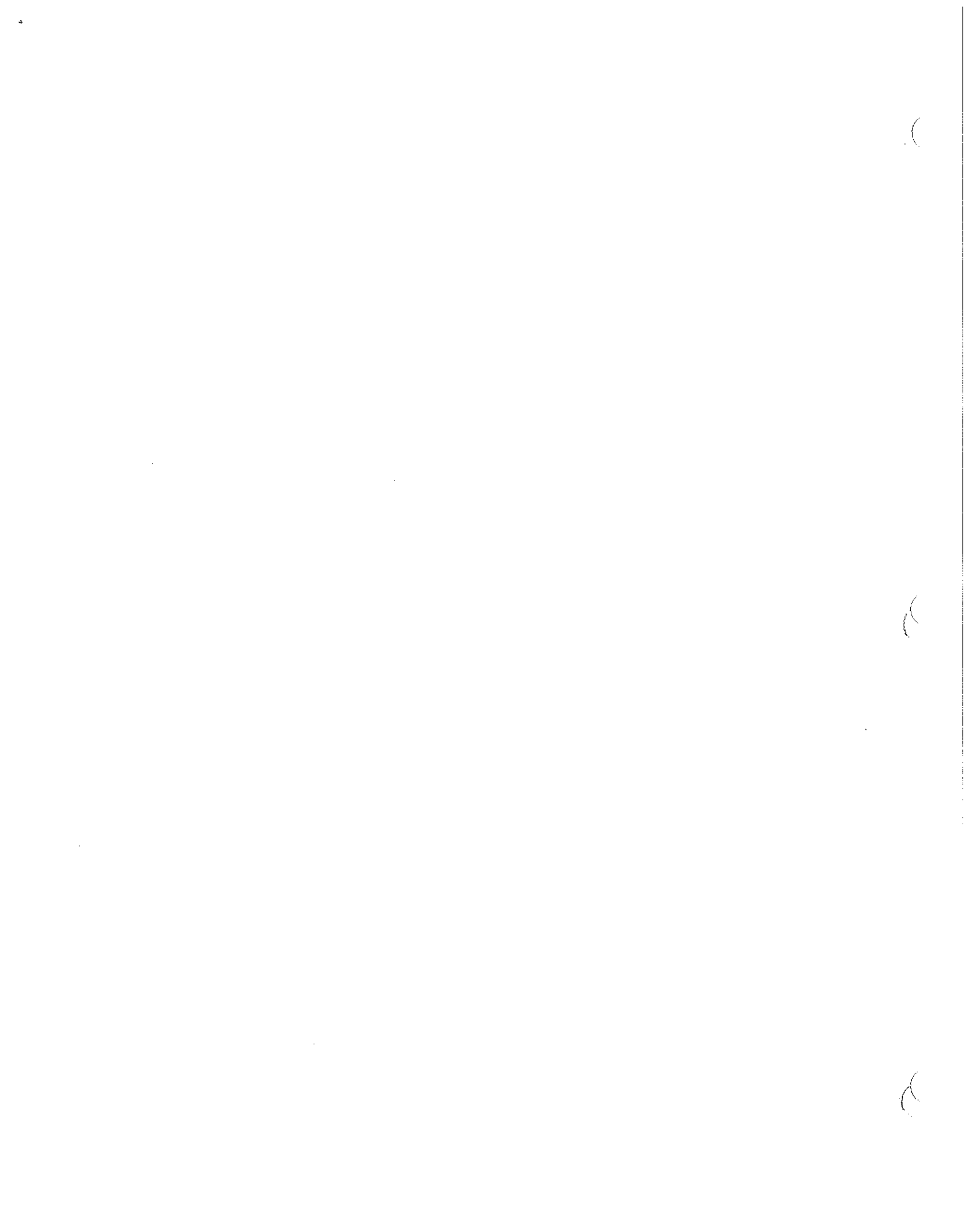
'B' BANK



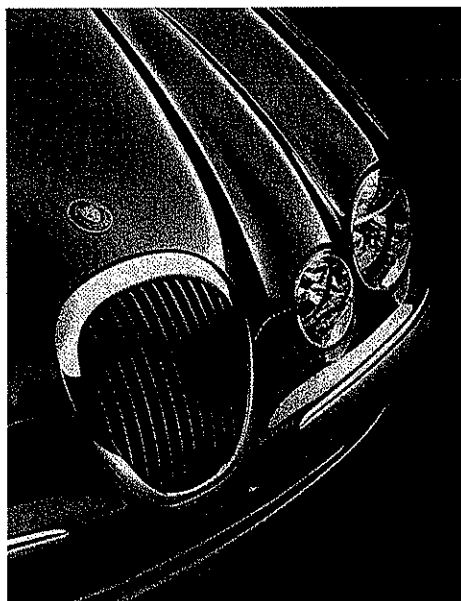
SNUG BOLTS 5 AND 6 TO ALIGN MANIFOLDS TO CYLINDER HEADS

TORQUE IN PAIRS 16 - 20 Nm (12 - 15 lb. ft.)
(1 & 2), (3 & 4), (5 & 6), (7 & 8)

T180/2.53



AJ-V6 ENGINE



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7 ENGINE DISASSEMBLY

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ENGINE OVERVIEW

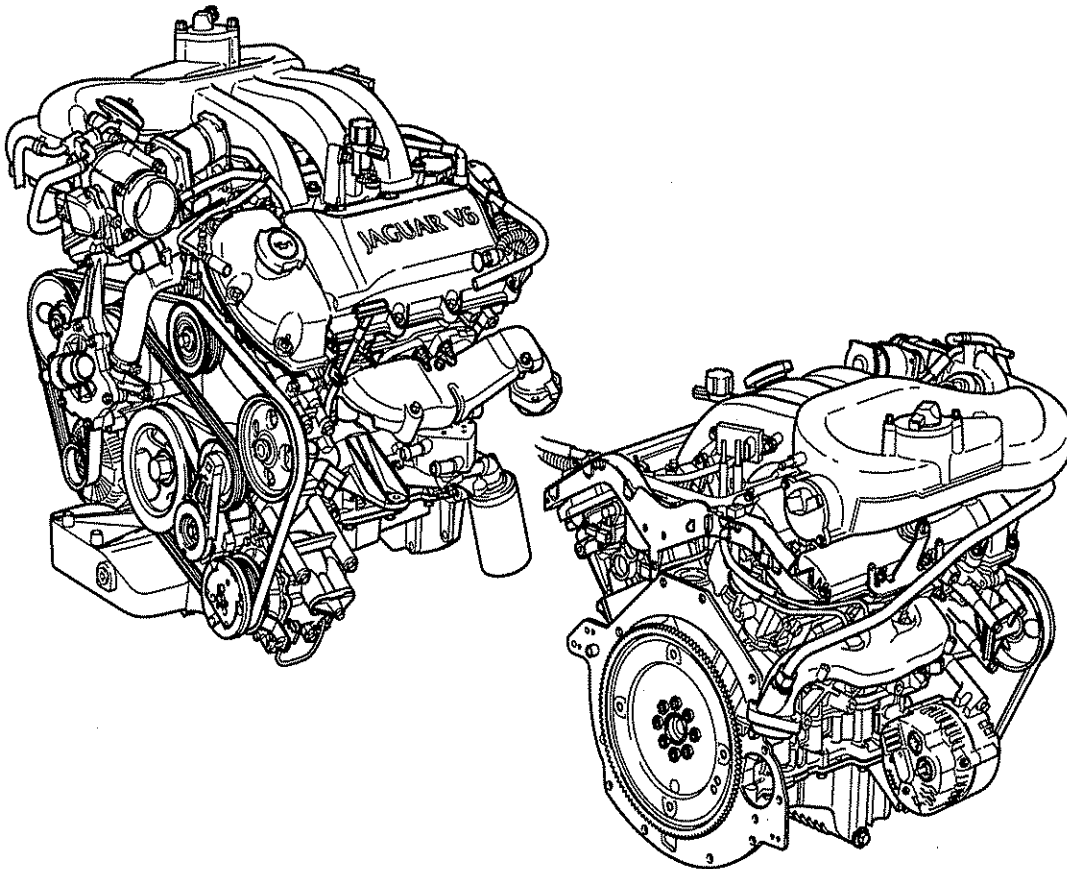
Introduction

The V6 engine is built at the Cleveland Engine Plant in the USA. The 3.0 litre 24 valve V6 engine has four overhead camshafts and are driven by two timing chains. The engine incorporates electronic engine management with distributorless ignition system, sequential electronic fuel injection and electronically controlled exhaust gas re-circulation (NAS only). It also has two catalytic converters in the exhaust system which includes two oxygen sensors and two catalytic monitor sensors.

Viewed from the driving position, the right hand cylinder bank (A) is numbered 1 to 3, from the front of the vehicle and the left hand cylinder bank (B) are numbered 4 to 6, from the front of the vehicle.

The AJ-V6 includes the following:

- 10.5:1 Compression ratio.
- 3 Stage variable geometry intake manifold.
- Lightweight valve gear.
- Two position variable camshaft timing (VCT) system.
- Twin knock sensor engine management control.
- Full authority electronic throttle control.
- 240 HP @ 6800 RPM -- 293 Nm Torque @ 4500 RPM



AJV.001

3.0L Engine

The 3.0L engine consists of:

- A six cylinder 60 degree 'V' configuration liquid cooled Aluminum cylinder block with dry steel liners.
- Aluminum pistons with cut-outs in the piston crown to clear the valve heads for any available combination of camshafts profile and valve phasing.
- Two Aluminum cylinder heads with square squish chambers.
- Two steel overhead camshafts per bank.
- Four valves per cylinder.
- Mechanical tappets and top mounted phosphate coated cast iron shims.
- Variable valve timing (VVT) of the inlet camshafts.
- Two silent timing chains with one hydraulic tensioner per chain.
- Plastic camshaft covers with rubber seals.
- A variable intake system containing two electrically controlled intake manifold tuning valves.
- Plastic lower intake manifold with integral fuel rail and injectors.
- Aluminum timing cover which accommodates the crankshaft front oil seal.
- An oil pump mounted around the crankshaft.
- An Aluminum bed plate.
- A steel crankshaft.
- Fracture-split connecting rods in sintered-forged steel.
- A single, six ribbed vee belt drives the front end accessories.
- An advanced engine management system incorporating electronic throttle control.
- The unit meets the requirements of the OBDII USA legislation.

Notes on Maintenance

Service Intervals

- Engine oil filter changed every 10,000 miles (16,000km) or 12 months.
- Renew spark plugs at 70,000 miles (110,000km).
- Spark plugs. GAP = 1.3 - 1.45mm.
- Firing order 1-4-2-5-3-6.
- Engine oil specification SAE 5w - 30.WSS-M2C-912A.
- Engine oil capacity (with filter 6.0 litre).
- Renew drive belt 100,000 miles (160,000km).
- Anti-freeze: change at 150,000 miles (250,000km) or 5 years.

Servicing Aluminum Engines

Never use metal scrapers to remove residue. Steel scrapers are capable of causing serious damage to Aluminum and plastic surfaces in the form of scratches and depressions. The result is leaks. A plastic or wooden scraper is essential for carrying out these kinds of operations.

IMPORTANT never attempt to clean gasket surfaces using grinders, rotating steel brushes or tools with cutting edges. Prevent gasket residue from entering the engine cover all engine orifices where possible. Be especially careful when installing components such as cylinder heads, intake manifolds, timing covers and oil pans as these are all critical areas with high potential for leakage.

ALWAYS replace used gaskets, regardless of condition or type of material. Observe the instructions on JTIS. Gasket sealer is not required on all gaskets, some gaskets are pre-shaped meaning that the application of sealant could lead to excess height or local distortion in the gasket, with leaks as the ultimate results.

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GENERAL SPECIFICATIONS (Continued)
ENGINE CODES

3.0L-4V DEW03		LINCOLN LS					
ENGINE CODE	EMISSIONS	MARKET	TRANS	EGR	ETA	OIL COOLER	HEAT SHIELD
3G-230-	LEV	US-50S, CANADA JAPAN	AUTO	YES	(C3) NO	NO	NO
3G-232-	LEV	US-50S, CANADA KOREA	AUTO	YES	(C3) NO	YES	LH

3.0L-4V X203		JAGUAR S-TYPE					
ENGINE CODE	EMISSIONS	MARKET	TRANS.	EGR	ETA	OIL COOLER	HEAT SHIELD
(A7) 3G-762-	STAGE III	NA	AUTO	NO	NO	NO	LH-RH
3G-766-	STAGE III	EAO, ROW	AUTO	NO	NO	YES	LH-RH
3G-767-	STAGE III	EAO, ROW	MANUAL	NO	NO	YES	LH-RH

2.5L-4V							
ENGINE CODE	EMISSIONS	MARKET	TRANS.	EGR	ETA	OIL COOLER	HEAT SHIELD
3G-436-	STAGE III	NA, EAO, ROW	AUTO	NO	NO	YES	LH-RH
3G-437-	STAGE III	EAO, ROW	MANUAL	NO	NO	YES	LH-RH

3.0L-4V X350		JAGUAR XJ					
ENGINE CODE	EMISSIONS	MARKET	TRANS.	EGR	ETA	OIL COOLER	HEAT SHIELD
2G-760-	STAGE III	NA, EAO, ROW	AUTO	NO	NO	YES	LH-RH

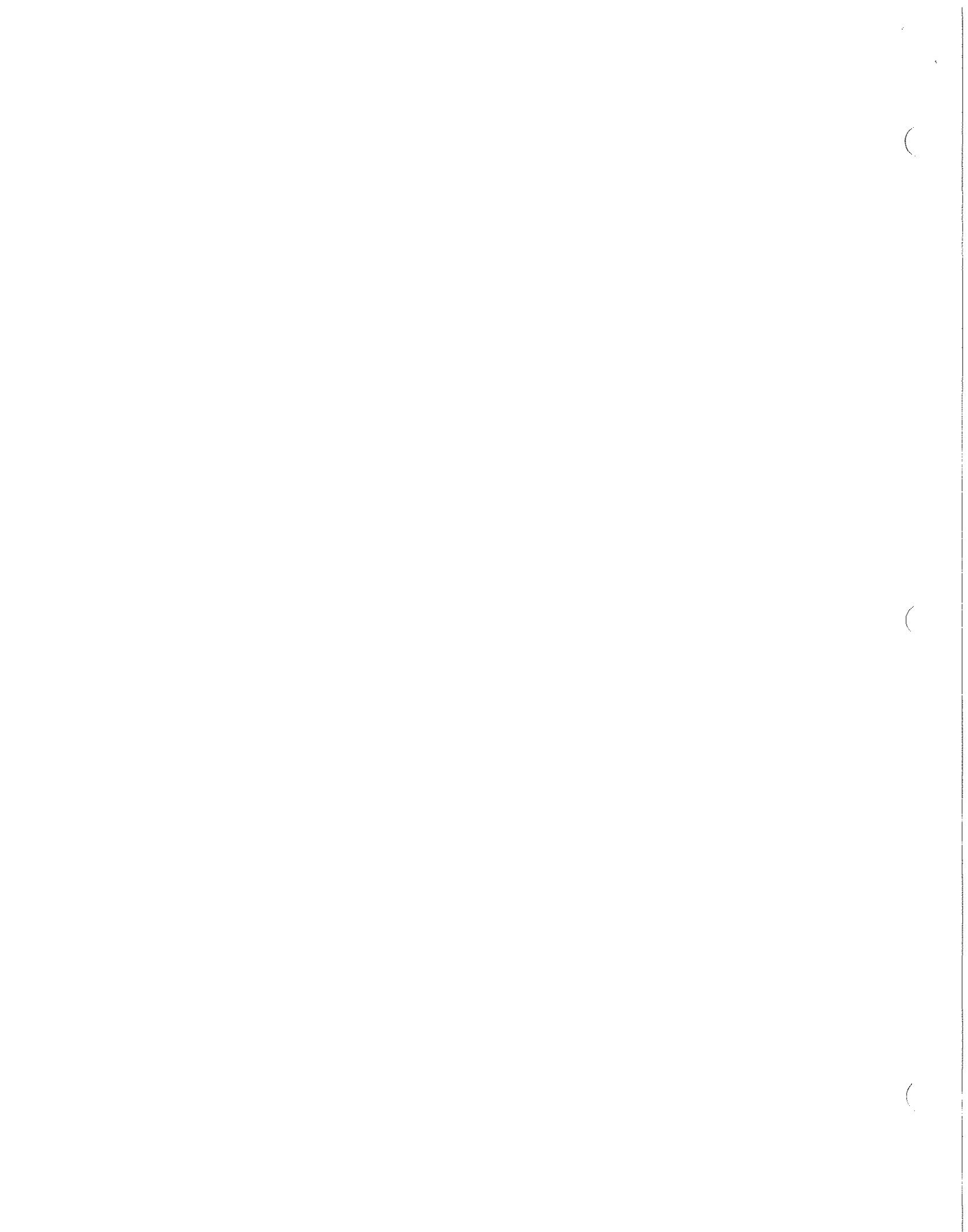
3.0L-4V X400		JAGUAR X-TYPE					
ENGINE CODE	EMISSIONS	MARKET	TRANS	EGR	ETA	OIL COOLER	HEAT SHIELD
1G-730-	LEV / STAGE III	ALL	AUTO	NO	NO	YES	NO
1G-731-	LEV / STAGE III	ALL	MANUAL	NO	NO	YES	NO

2.5L-4V							
ENGINE CODE	EMISSIONS	MARKET	TRANS	EGR	ETA	OIL COOLER	HEAT SHIELD
1G-430-	LEV / STAGE III	ALL	AUTO	NO	NO	YES	NO
1G-431-	LEV / STAGE III	ALL	MANUAL	NO	NO	YES	NO

2.0L-4V							
ENGINE CODE	EMISSIONS	MARKET	TRANS	EGR	ETA	OIL COOLER	HEAT SHIELD
2G-420-	LEV / STAGE III	ALL	AUTO	NO	NO	YES	NO
2G-421-	LEV / STAGE III	ALL	MANUAL	NO	NO	YES	NO

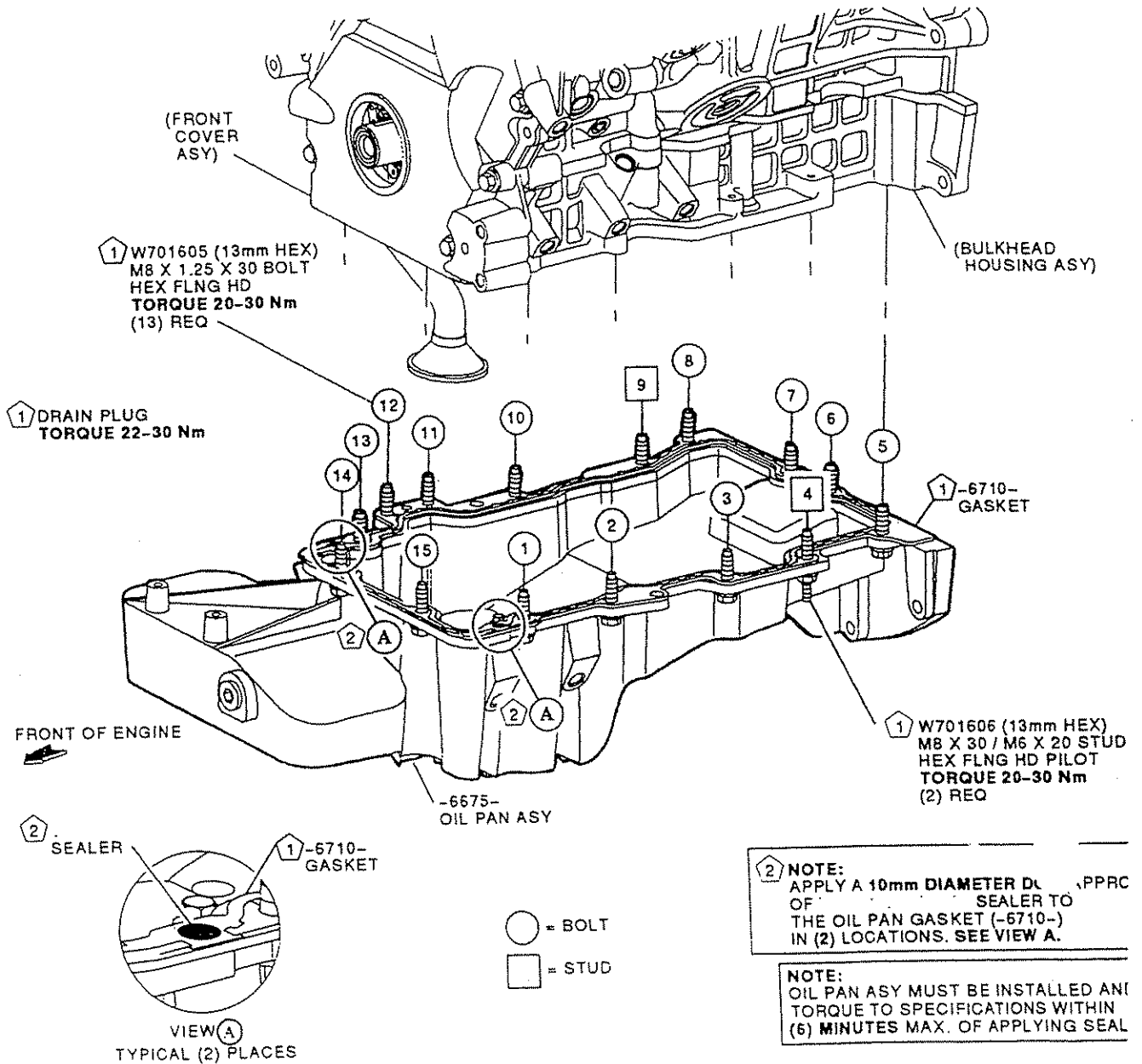
GENERAL SPECIFICATIONS

REL	NE01-E11433990-000	2003 2.0L / 2.5L / 3.0L-4V DAMB	DATE	030217	LAST FRAME	80
<i>Ford Motor Company</i>	V-ENGINE ILLUSTRATION	NO. ∇ IL3W9E-030002-A0543F	REV	C3	FRAME	3C
					CONTD	3D



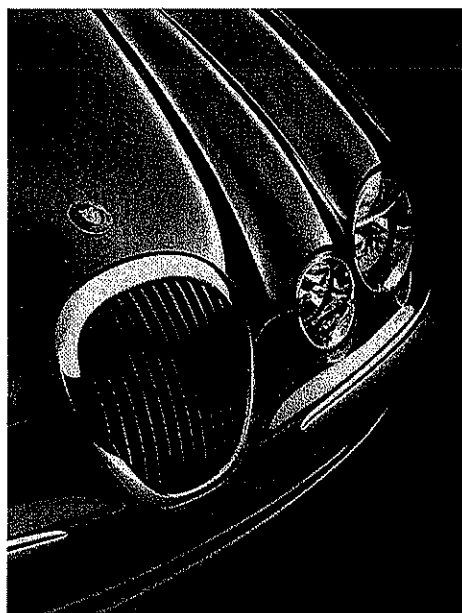
OIL PAN ASY

NOTE:
ALIGN TRANSMISSION MOUNTING FACE OF OIL PAN WITH REAR FACE OF CYLINDER BLOCK. IT MUST HAVE A MAXIMUM MISMATCH OF .10mm OVERFLOW TO .25mm UNDERFLUSH. IF STEP IS GREATER THAN .25mm, IT WILL REQUIRE RE-INSTALLATION OF OIL PAN ASY.



X200							
ENGINE CODE	EMISSIONS	MARKET	TRANS.	EGR	ETA	OIL COOLER	HEAT SHIELD
9G-762-AA	LEV	50 STATES & CANADA	AUTO	YES	NO	YES	LH
9G-766-AA	STAGE III	MEXICO EAO, ROW	AUTO	NO	NO	YES	LH-RH
9G-767-AA	STAGE III	EAO	MANUAL	NO	NO	YES	RH
9D-768-AA	GCC	EXPORT	AUTO	NO	NO	YES	LH
9D-769-AA	TRC	X200 EXPORT BRAZIL	AUTO	NO	NO	YES	LH-RH

AJ-V6 ENGINE



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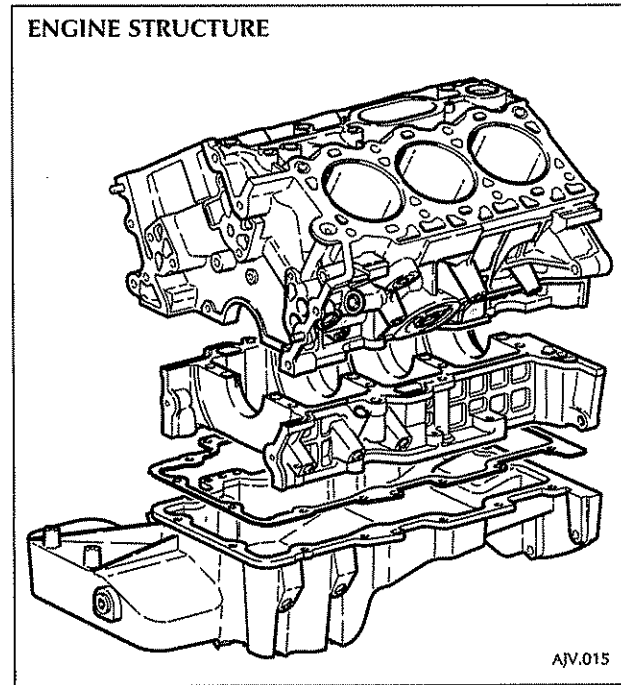
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BASIC ENGINE

Engine Structure

- Basic engine construction is similar to the V8 in that a structural bedplate is used.
- The bedplate bolts to the cylinder block providing a very strong unitized housing for the crankshaft which also minimises vibration.
- Both units are of cast aluminum alloy and are accurately aligned together by the use of eight hollow dowels. The cylinder block is fitted with dry cast iron liners.
- The oil sump is an aluminum alloy casting which combines a sump body and oil pan in a single structural component. The sump mounts to the bedplate via an aluminum gasket incorporating a silicone rubber seal.

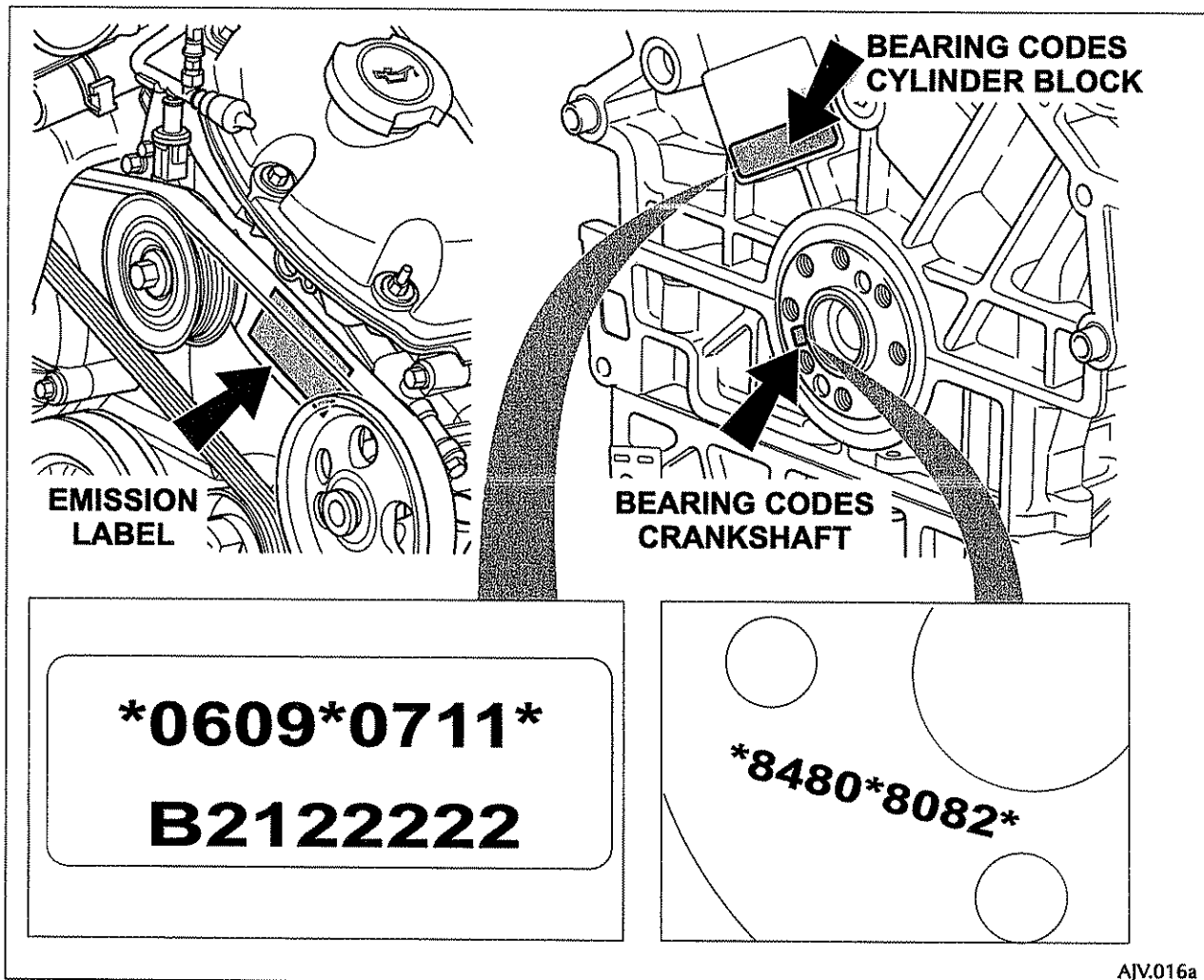


Engine Identification Data

An emissions identification code tag is located on the front cover assembly

The engine identification code is stamped on the left hand side of the block (not illustrated).

Main bearing selection codes are located at the rear of the cylinder block and on the rear face of the crankshaft flange. The two codes are compared using reference data to identify the correct bearing.



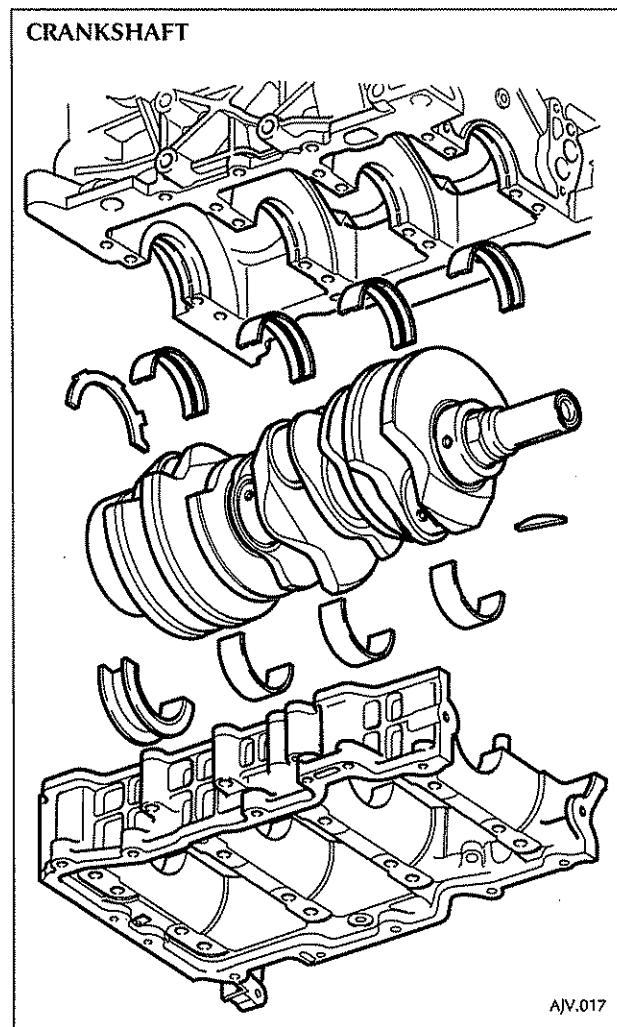
Crankshaft

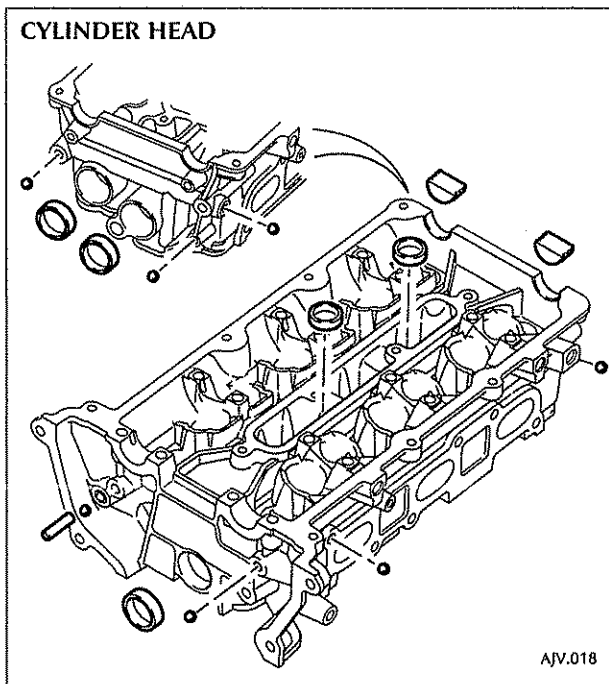
The forged steel crankshaft runs in four Aluminum/tin main bearings with the lower bearing shells supported in cast iron inserts in the bedplate. Fore and aft location of the shaft is set by the rear bearing assembly which consists of an upper shell and thrust half washer and a lower, flanged, thrust bearing shell. A keyway locates the crankshaft timing sprockets, timing pulse ring and crankshaft damper to the crankshaft.

Connecting Rods and Pistons

The connecting rods are manufactured from sintered iron. The bearing caps are produced by the fracture split method (as used on the V8 engines) to provide a strong, accurately mated assembly. Bearing shells are of Aluminum/tin alloy.

The pistons are made of Aluminum alloy with valve cut-outs in the piston crown to allow for the extra inlet timing advance of the VVT system. Four cut outs are provided to enable a common piston to be used in each engine bank. The piston is fitted with two compression rings and an oil control ring assembly.





Cylinder Head Assembly

Cylinder Head

The Aluminum alloy cylinder heads have square squish combustion chambers with four valve ports and a central spark plug. Each head is aligned to the cylinder block via two split hollow dowels and sealed with a composite stainless steel gasket. Steel balls (10.11mm diameter) are used to plug the external bores of the oilway drillings and cup plugs are fitted to the water jacket openings. Two half round Aluminum cap inserts are fitted via a sealant at the rear of the head.

Cam Cover

The cylinder heads are fitted with lightweight polyester cam covers, (left hand bank is coloured silver) with silicone seals, to save weight and reduce airborne noise. A central aperture allows access to the coil on plug units and a second hole has a grommet through which the VVT oil control valve protrudes. The oil filler hole is in the LH cover.

Camshafts and Valve Gear

The basic camshaft consists of individual machined cam lobes, thrust washer and end plug assembled on a steel tube. The exhaust camshafts also have a pressed on drive sprocket, forming a single camshaft assembly. On the inlet camshaft the drive sprocket is fixed to the VVT unit which is removable but the rear end of the camshaft is fitted with a pressed on multi-tooth sensor ring. Each camshaft is supported in four bearings with the front (thrust) bearing cap having a special oilway for the VVT unit (see VVT section): on the exhaust camshaft this oilway is redundant. The bearing caps are made of Aluminum.

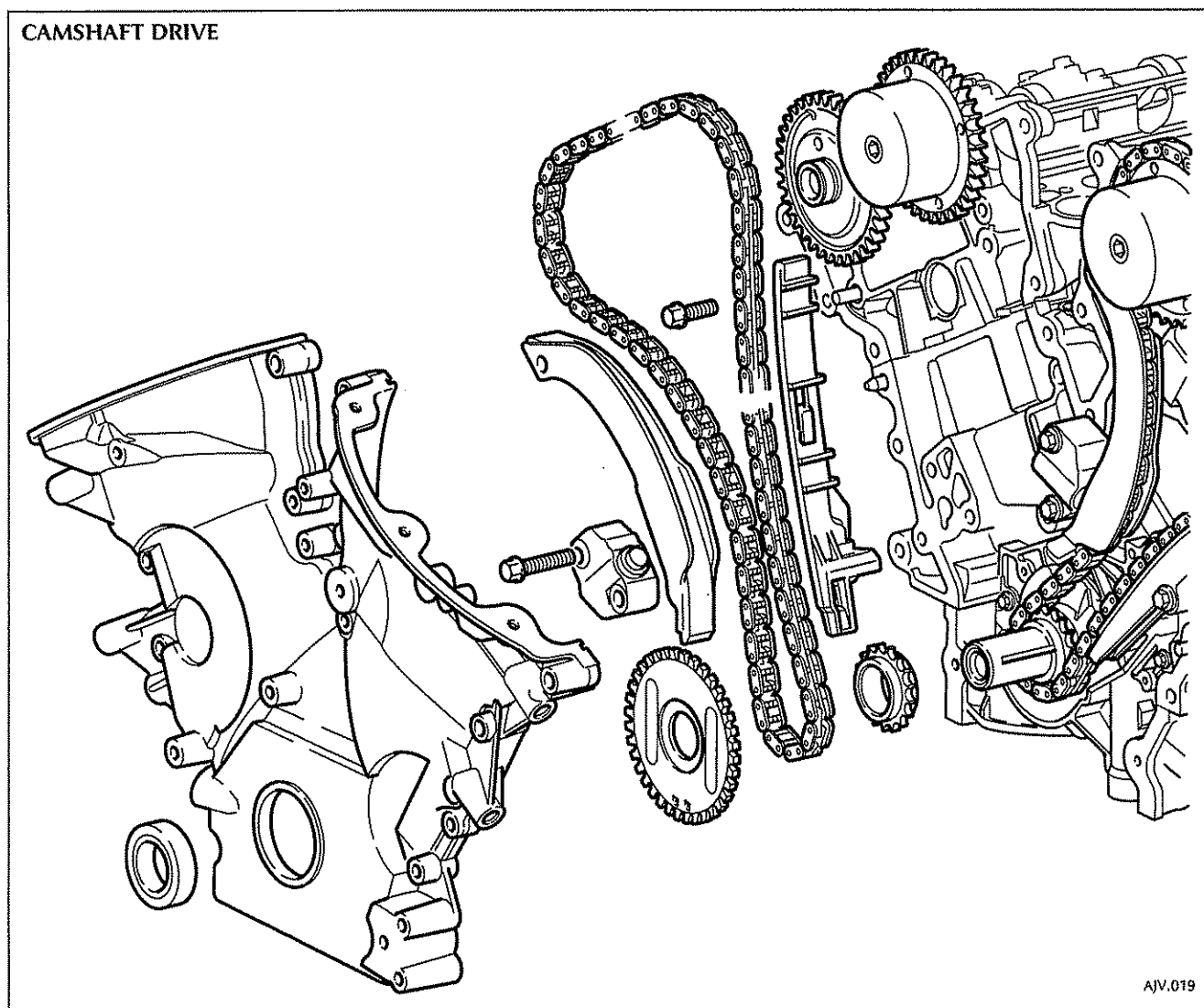
The cams actuate the valves via direct acting mechanical bucket tappets made of lightweight Aluminum with phosphate coated cast iron shims mounted on top. The valve components are of lightweight design with 5.5mm valve stems.

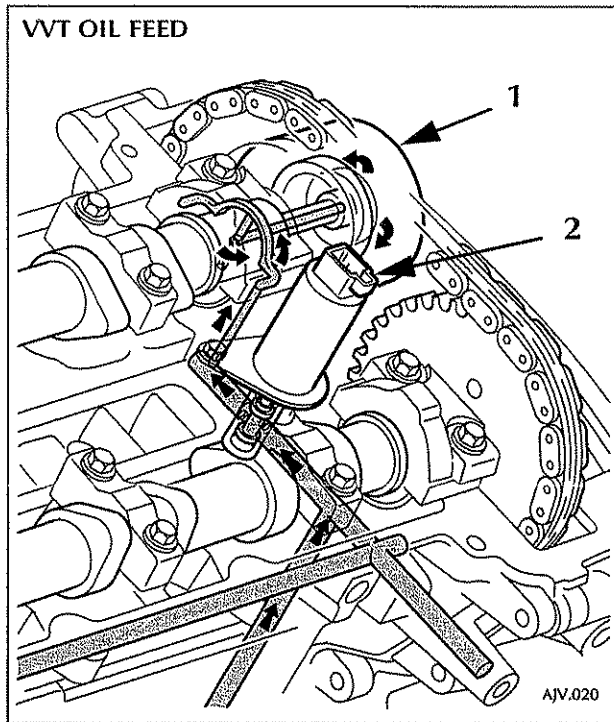
Camshaft Drive

Two timing chains are used, one for each cylinder bank and driven by separate sprockets keyed to the crankshaft. The chains are of the silent-type, with a multiple link construction and sprocket engagement on one side only.

Each chain has a hydraulic tensioner, fed from the engine oil supply, which acts on a pivoted tensioner arm with side flanges. Fixed guides bear on the drive side of the chains and are unique to each side.

A single piece Aluminum alloy front cover is aligned to the cylinder block by two dowels and encloses the timing gear. The crankshaft front oil seal fits into the front cover and the inner lip bears on the crankshaft damper.





1. VVT Unit
2. VVT Oil Control Valve

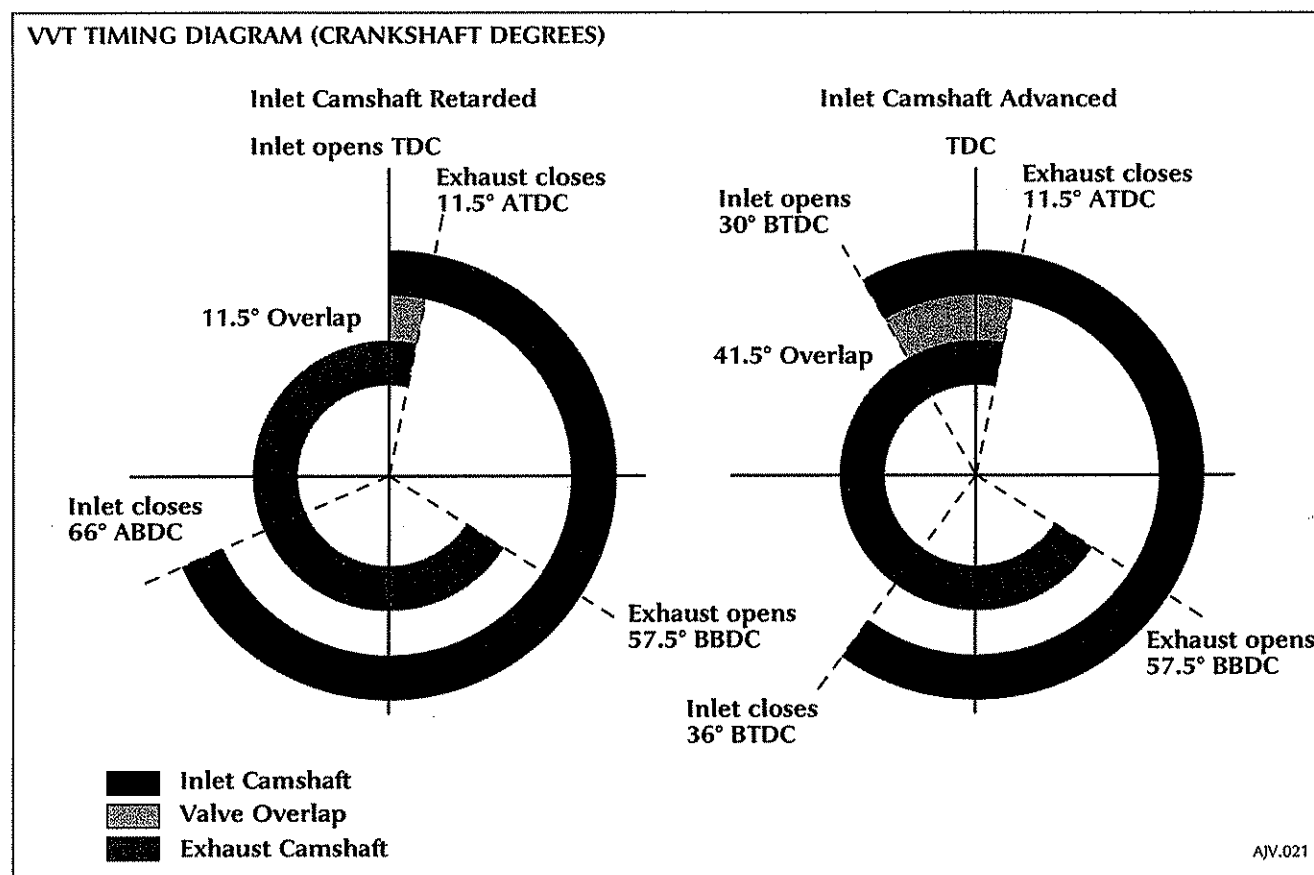
Variable Valve Timing (VVT)

A VVT system is used to allow the phasing of the inlet valve opening to be changed relative to the fixed timing of the exhaust valves. Two positions are used, 30° apart, with the advanced position occurring at 30° BTDC and overlapping with the exhaust opening. The system is similar to that previously used on the AJ26 V8 engine but uses different components and a different oil feed arrangement.

The operating regime is controlled by the engine management system in conjunction with the variable geometry induction system so as to optimise torque characteristics over the engine speed/load range. The engine torque curve with VVT operating points is shown in the section on the Variable Intake System. The VVT system also provides increased amounts of 'internal' EGR under certain speed/load operating conditions.

VVT Oil Feed

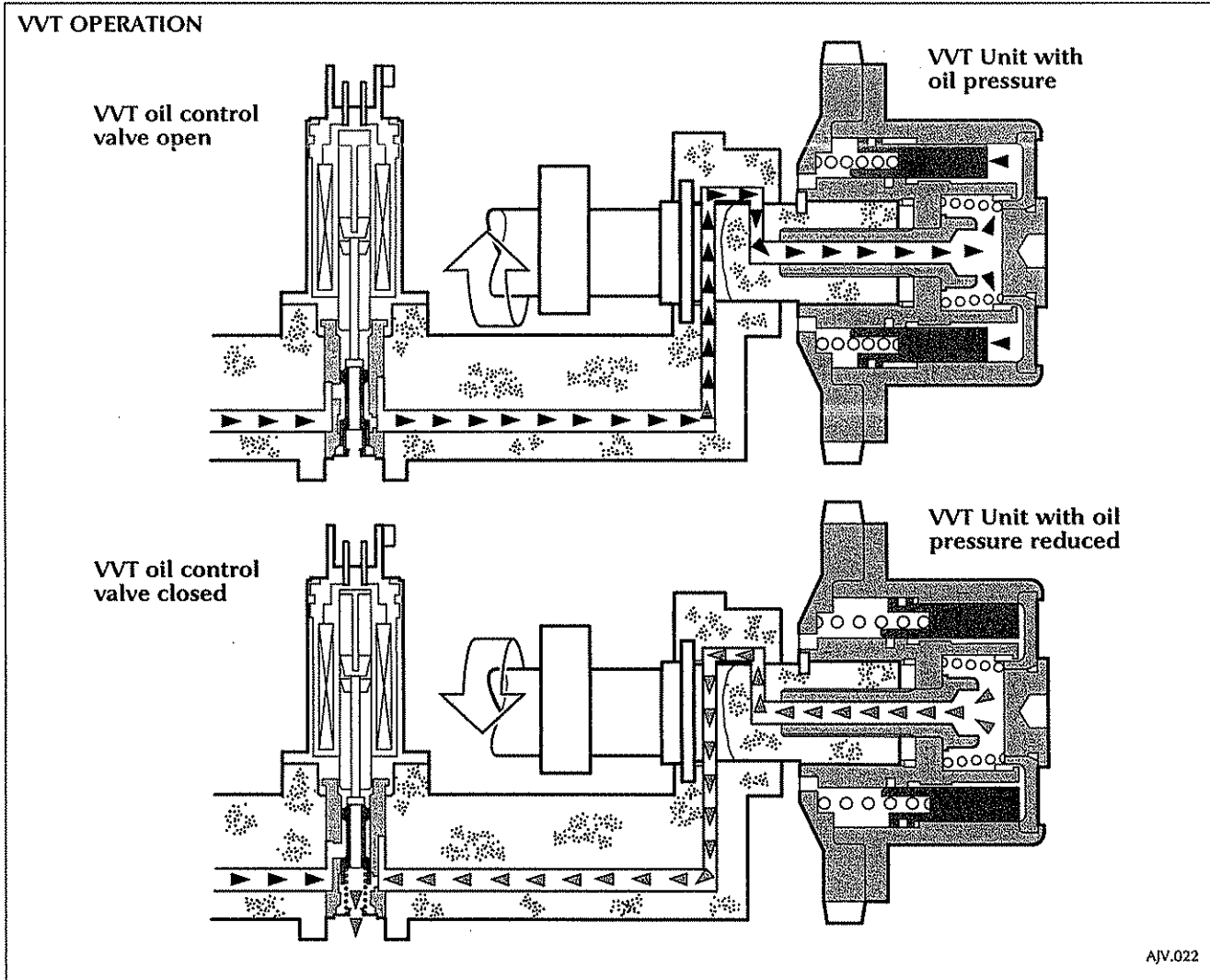
The VVT/sprocket unit is fixed on the nose of the inlet camshaft via a locating pin and hollow bolt and is driven directly by the timing chain. Unlike the VVT systems on the V8 engines, the oil feed to each VVT unit is supplied via fixed oilways in the cylinder head and not through a separate bush carrier. This arrangement requires a feed through the camshaft side of the VVT unit from the main cylinder head supply. The oil feed is controlled by the VVT oil control valve, a solenoid operated shuttle valve, which is bolted directly to the cylinder head. From the oil control valve, the flow is via the thrust bearing cap, through drillings in the camshaft and then through the hollow fixing bolt which secures the VVT unit. Drain holes are provided at the rear (camside) face of the VVT unit for any residual oil which has seeped past the piston.

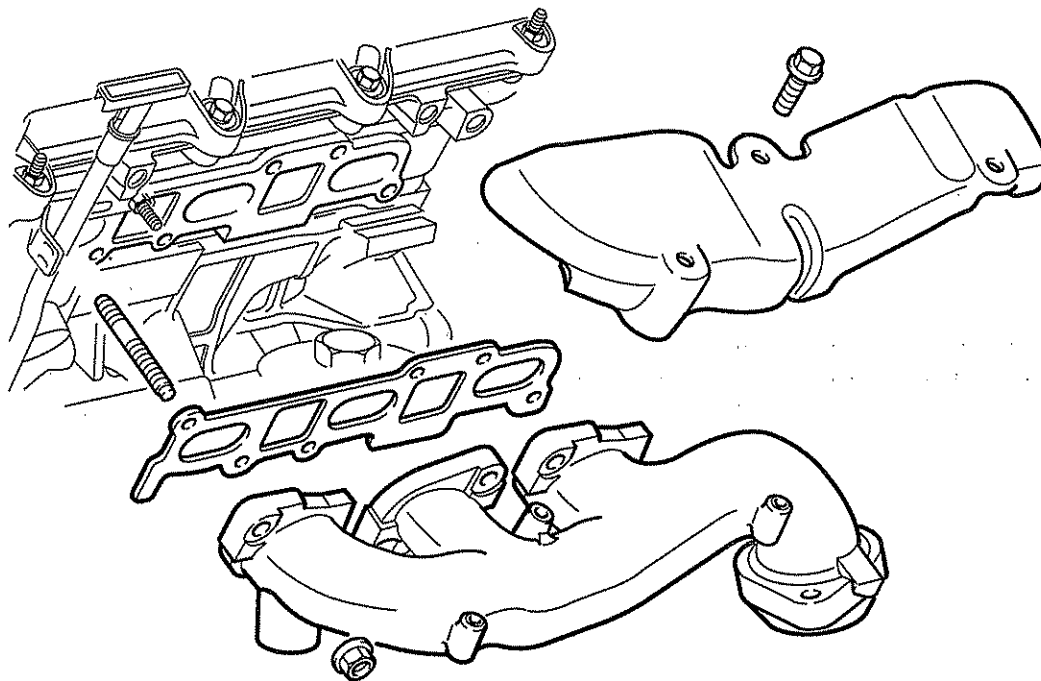


Operation

Operation is similar to that of the two stage V8 VVT system. With the oil control valve open, oil pressure on the helical drive piston is increased, rotating the cams to the advanced position. When the valve closes, oil pressure reduces and the return spring pushes the piston back to the fully retarded position.

The oil control valve is controlled by a 300Hz PWM signal from the PCM which sets it to either the fully open or fully closed position.



EXHAUST MANIFOLD AND HEATSHIELD

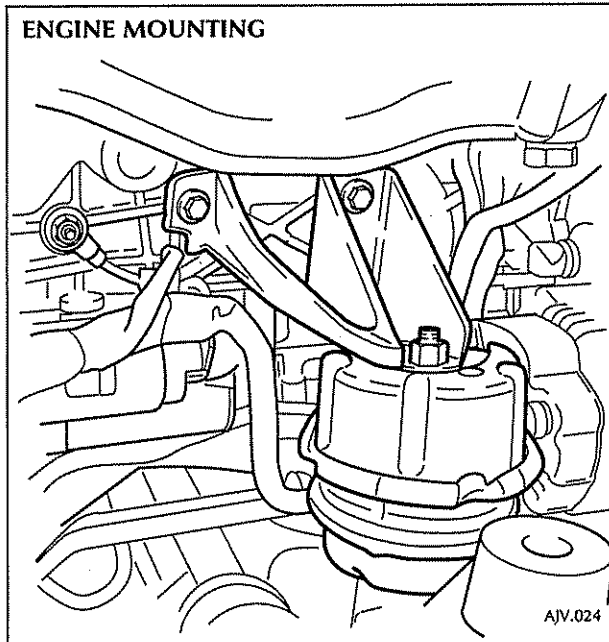
AJV.023

Exhaust Manifold

The exhaust manifolds are of cast iron with a threaded hole in the right hand bank manifold for the EGR pipe or blanking plug (if EGR not fitted). Each manifold is fitted with a heat shield constructed of a fibre compound sandwiched between an Aluminum coated carbon steel shell.

Engine Mountings

The engine is supported at each side on hydramounts fitted between the Aluminum alloy engine brackets and the No 2 front cross member. The hydramounts are similar to those on the XJ and XK Series and have an integral heat shield and anti-separation restraint.

ENGINE MOUNTING

AJV.024

Air Induction System

Air Intake

The air induction system consists of the intake ducting and air cleaner, the throttle body, tuned manifold assembly and lower manifold.

The air cleaner connects to the throttle body via a lateral mounted intake pipe with resonator box. A separate duct, housing the MAF sensor, fits between the air cleaner and resonator pipe. The IAT sensor is located in the intake resonator pipe.

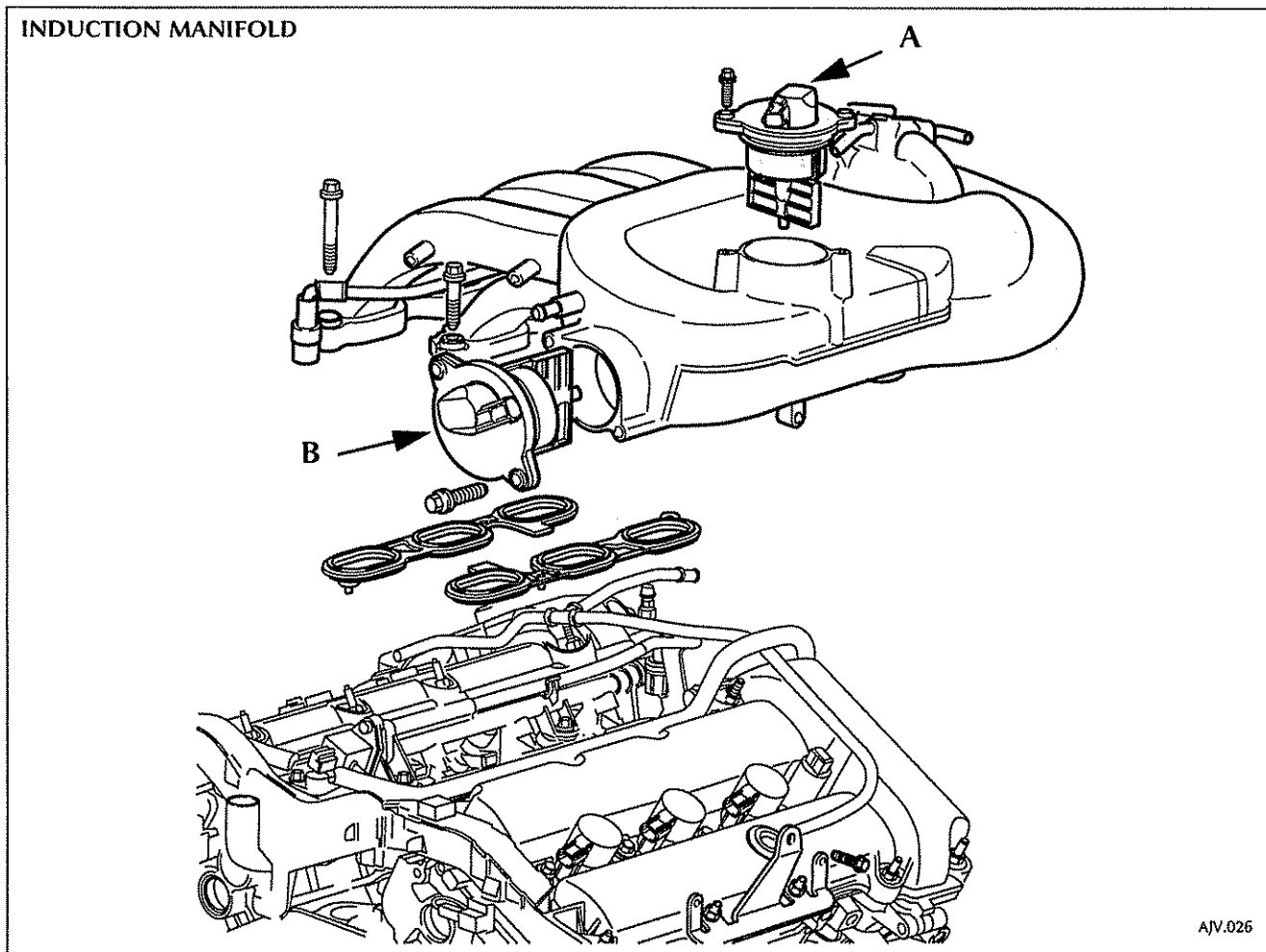
Variable Intake System

The induction manifold is specially designed to optimise torque across the engine speed/load range. The air charge enters the induction manifold from the throttle body and passes through a plenum chamber for distribution to the cylinders via the manifold runners. The function of the plenum chamber is to provide a resonance (or maximising) effect such that large pulses of charge air are produced which will arrive at the inlet ports at the correct time for induction into the cylinders. This ram charging action is only effective over a restricted speed/load range for a particular plenum chamber volume and geometry. To extend the effect over the whole engine speed range, the manifold geometry can be set to three different configurations, each of which maximises the tuning effect over different parts of the range. This variable geometry is achieved by the use of two intake manifold tuning (IMT) valves, which are controlled by the engine management system.

Construction

The induction manifold is a single piece Aluminum alloy casting which mounts to the cylinder head induction ports via the lower manifold assembly. The plenum chamber is split into upper and lower compartments with two connecting holes and each compartment is fitted with an IMT valve.

The IMT valves are identical, solenoid operated, with a gate or paddle which rotates through 90° between open and closed positions. The valves can only be set to either of these two positions.



IMT Valve Operation

The two IMT valves (A & B) are set to one of the following combinations:

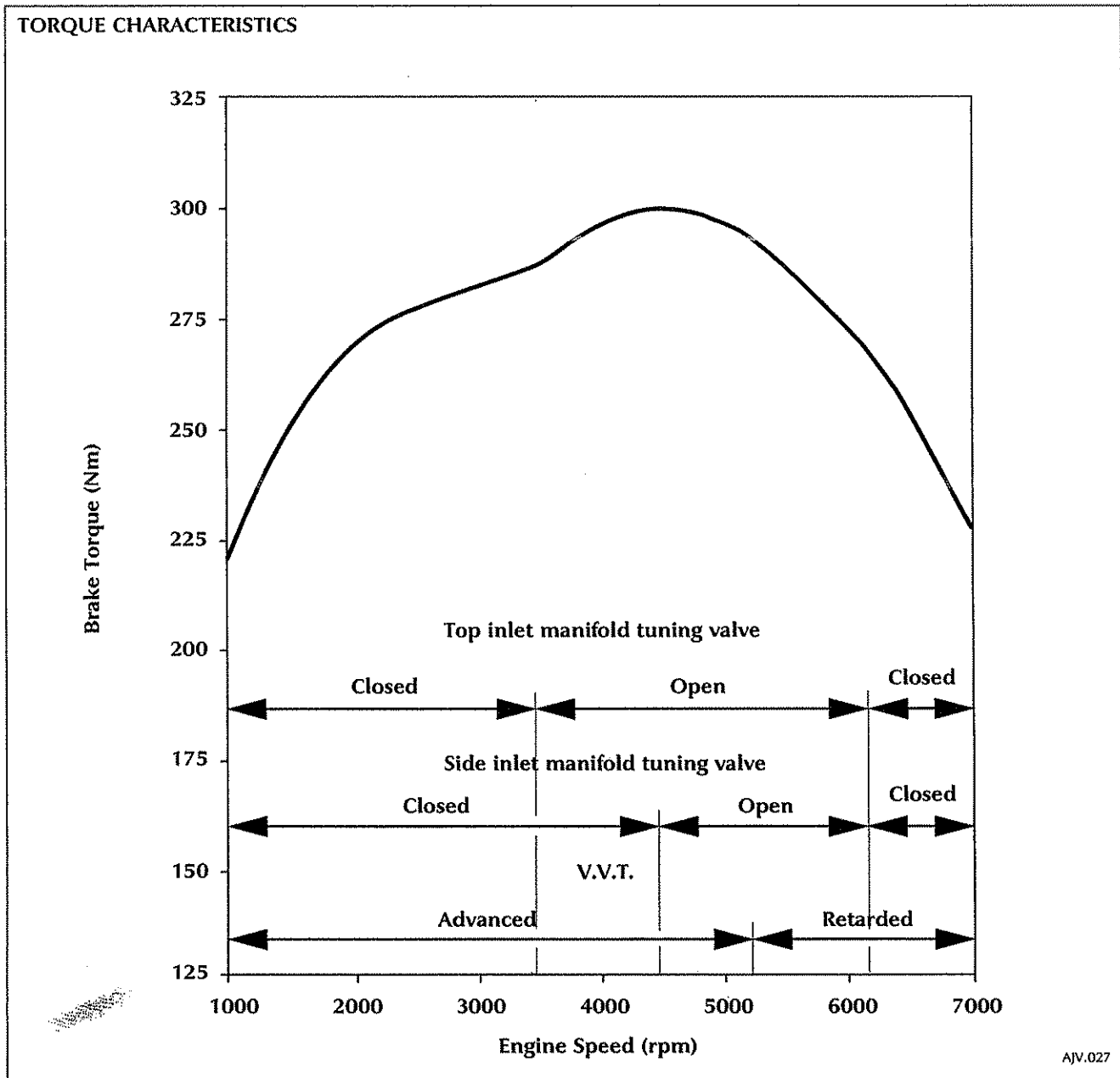
With both valves closed, there is no communication between the upper and lower plenum chambers and the ram charge effect is not present.

With the top valve (A) open and the bottom valve (B) closed, the upper and lower plenum chambers are linked via the front connecting hole allowing pressure waves to be communicated and creating the ram charge effect.

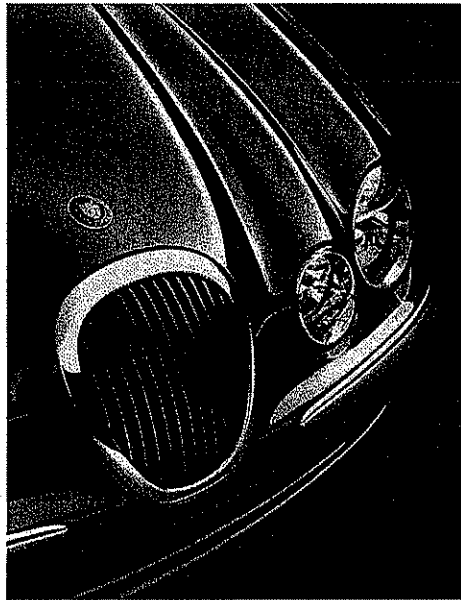
With both valves open, a second link is opened between the upper and lower chambers via the rear connecting hole, further increasing the ram effect via the rear connecting hole.

System Performance

The valve open/close combinations across the engine speed range have been selected in conjunction with the VVT system to provide an optimised torque curve. Referring to the graph, it can be seen that there are five states that the IMT valves and VVT can adopt throughout the engine speed range.



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LUBRICATION SYSTEM

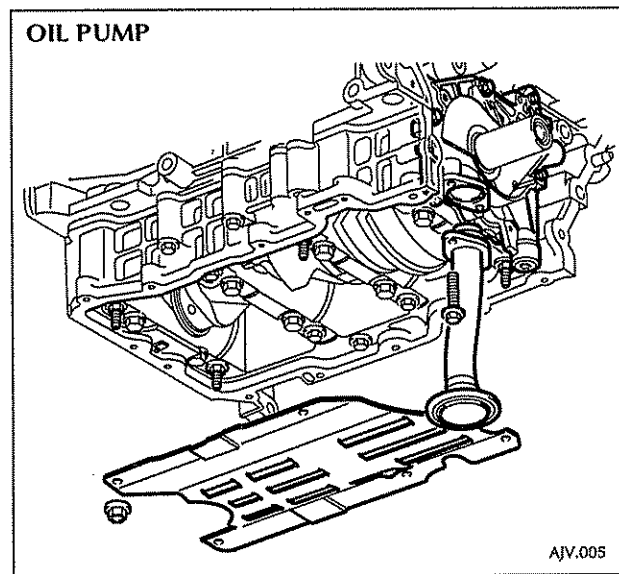
Oil Distribution

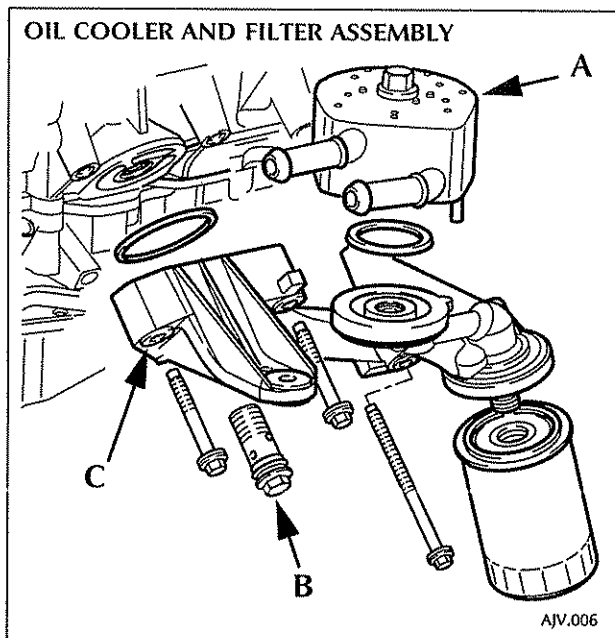
Oil distribution within the block and cylinder head is similar to that of the V8 engine. The main differences are in the filter and cooler arrangement and the method of supplying the VVT system.

Oil is drawn from the sump through the strainer by the crankshaft driven pump and passes through the externally mounted filter and oil cooler and returns to the block. Distribution is via the main gallery and crankshaft oilways to the lower crankcase components and via branch feeds to the chain tensioners and then cylinder head components. Extra oilways in the cylinder heads provide a built-in feed for the VVT components.

Oil Pump

The oil pump is of the inner/outer rotor type with the directly driven inner rotor located via flats on the crankshaft and the body of the pump bolted to the cylinder block. The oil pressure relief valve is located in the lower LH side of the pump. An oil pick-up tube and strainer is bolted to the pump inlet and projects directly down to the sump. Oil foaming is reduced by the windage tray bolted to the underside of the bedplate.





Oil Cooler and Filter Mounting

The oil filter and oil cooler (A) are mounted slightly away from the cylinder block on an aluminium alloy adaptor (C) which is an integral extension of the LH engine mount. The oil filter is a replaceable canister screw on type and the cooler is fixed by a single through bolt to the adaptor. Both components are connected to the cylinder block through internal oilways in the adaptor casting and via an interfacing filter mounting in the block. A hollow bolt (B) passes through the adaptor/engine mount and screws into the centre channel of the block filter mounting to provide the oil return from the cooler to the cylinder block.

The adaptor mounted oil cooler is an oil to water heat exchanger and the coolant matrix is connected via hoses into the main coolant system at the radiator bottom hose.

Engine Cooling

Cooling System

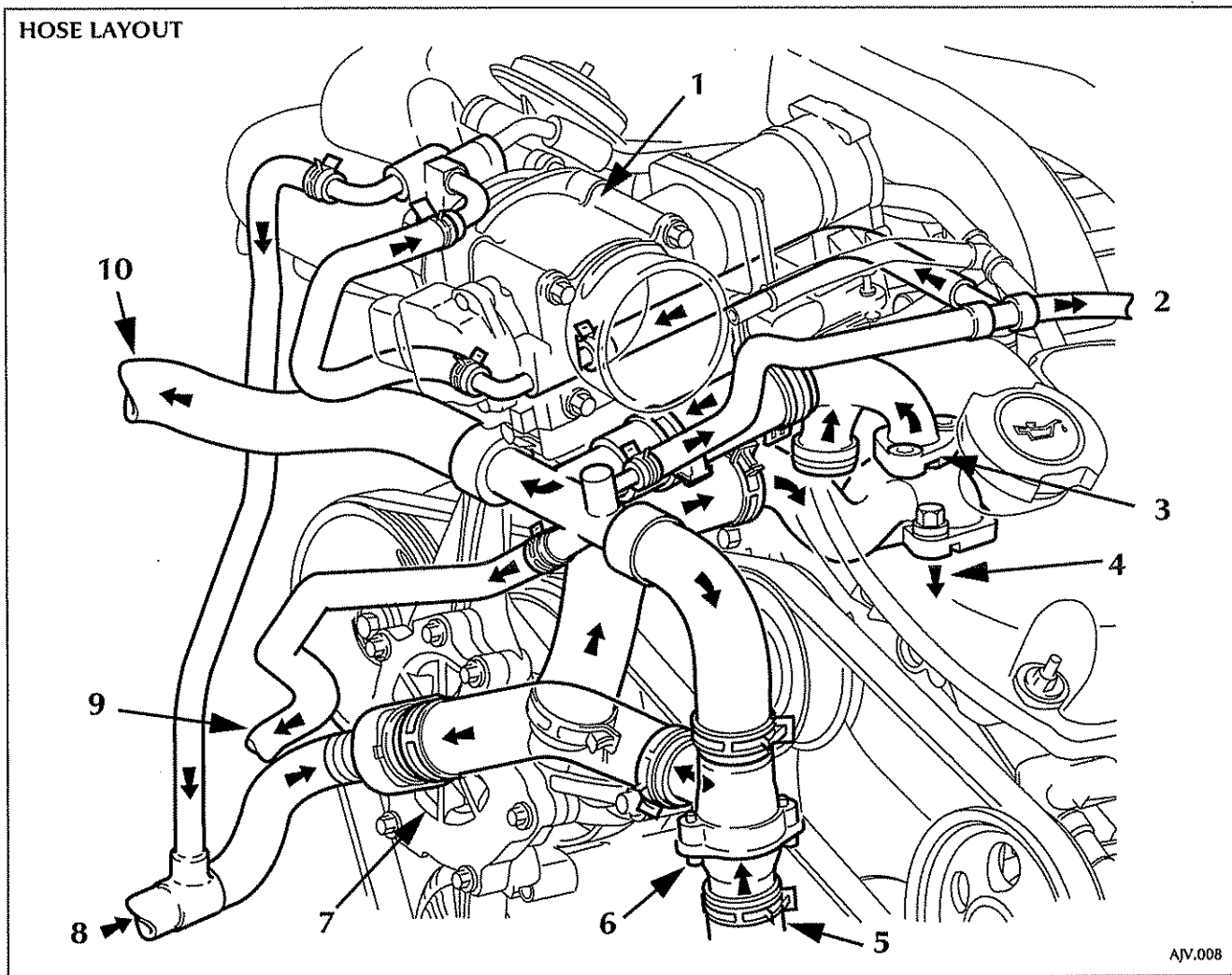
Engine cooling is via a conventional re-circulation system between the engine assembly and front mounted coolant to air radiator. Coolant flow is from the front of the engine, dividing to pass around each bank of cylinders towards the rear and then flowing forward through the cylinder heads. The coolant from the engine returns to the top RH side of the radiator by-pass circuit and also provides the hot input feed to the cabin heater system. The bottom hose feeds coolant from the radiator via the thermostat to the coolant pump and also provides the cooling circuit for the oil. A differential pressure orifice in the bottom hose causes a flow through the engine mounted oil cooler.

A coolant reservoir system (or de-gas system) is used which is similar to previous (pre 1998MY) vehicles. The reservoir bottle is mounted at the rear left (LHD vehicles) or rear right (RHD vehicles) of the engine bay and in the LHD location has a bleed valve on the return pipe running across the bulkhead. (The pipe layout is shown in the 'S-TYPE Introduction' Technical Guide.) A dip tube within the bottle ensures that coolant is drawn back into the engine when it cools down.

A subsidiary circuit provides a series coolant feed through the lower throttle body and top of the intake manifold inlet. This is necessary to prevent ice forming at low ambient temperatures at the base of the throttle body and also in the positive crankcase ventilation (PCV) port.

Hoses

Coolant ducting consists of flexible hoses, aluminium tubing and plastic tubing with injection moulded rubber to plastic joints. All coolant hose clamps are of the spring band type and are glued to the hose with a pull off clip for fitting. The thermostat is enclosed in an aluminium casting which is separate component supported by hose connections.



- | | |
|------------------------|------------------------------|
| 1. Electronic Throttle | 6. Thermostat |
| 2. To Reservoir Bottle | 7. Coolant Pump |
| 3. From Engine | 8. From Heater Control Valve |
| 4. To Engine | 9. To Heater Control Valve |
| 5. Bottom Hose | 10. Top Hose |

Coolant Pump - (Refer to JTIS for coolant system bleeding procedures)

The coolant pump is fitted via three bolts to the engine front cover. The pulley is mounted inboard of the pump assembly, between the pump and front cover, and has a smooth surface which is driven from the outer, non ribbed side of the drive belt.

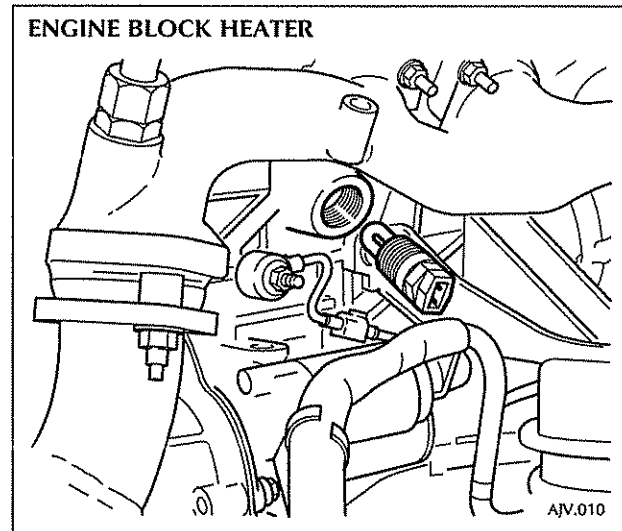
Coolant returns from the radiator and cabin heater system are connected via hoses to inlets on the front of the pump assembly. The outlet from the pump is connected to the engine block via a hose and a tubular casting bolted to the top front of the block between the cylinders.

Coolant

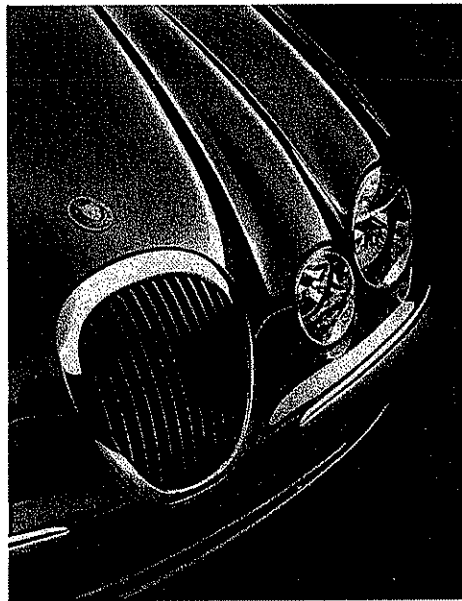
A new type of anti-freeze fluid is used for the coolant mixture. This product is a conventional ethylene glycol based fluid but with new organic corrosion inhibitors instead of the silicate, nitrite and other additives which are normally used. These new corrosion inhibitors do not form a deposit on the inner surfaces of the coolant system and therefore provide improved heat transfer (more efficient cooling), better component protection and an extended coolant life due to the low rate of depletion of the additives. The recommended coolant change is every five years or 150,000 miles (250,000km).

Engine Block Heater

For markets subject to very low temperatures, an engine coolant heater, for connection to an external mains electrical supply, is screwed into the RH side of the cylinder block adjacent to the knock sensor. Two heaters are available, a 400W 115V unit with a two pin connector and a 600W 230V unit with flying lead.



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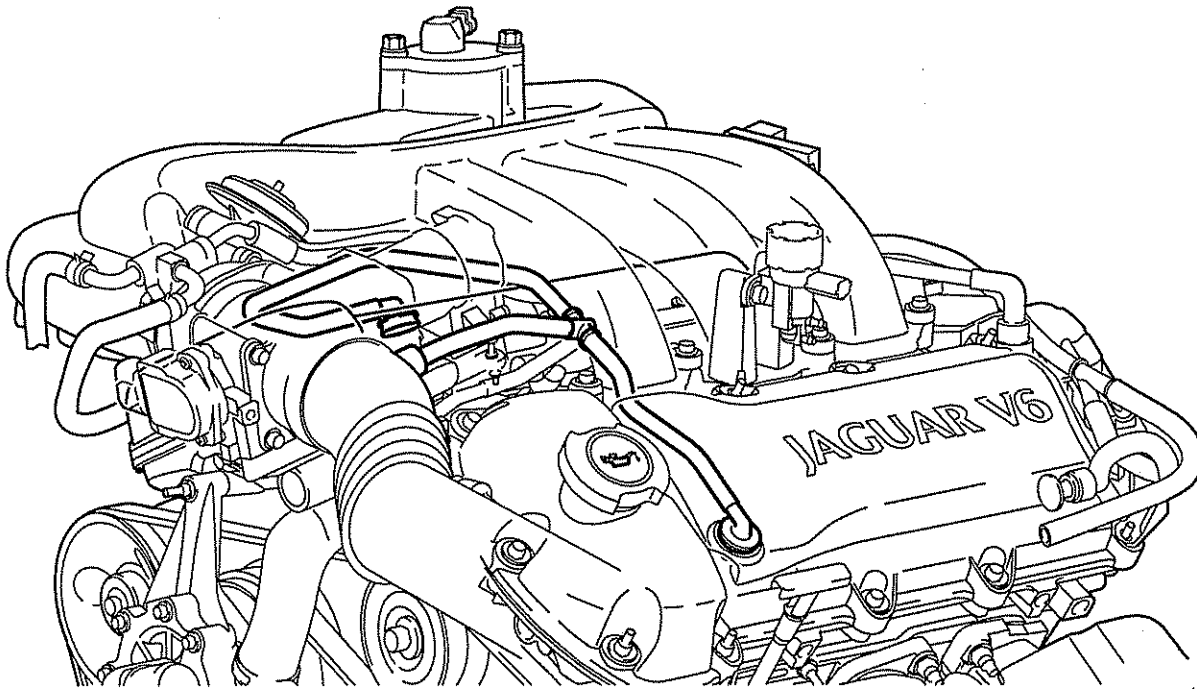
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CRANKCASE VENTILATION

Full Load Ventilation

Breather outlets on each cam cover are connected via hoses and a T junction to the intake duct to provide full load crankcase ventilation.

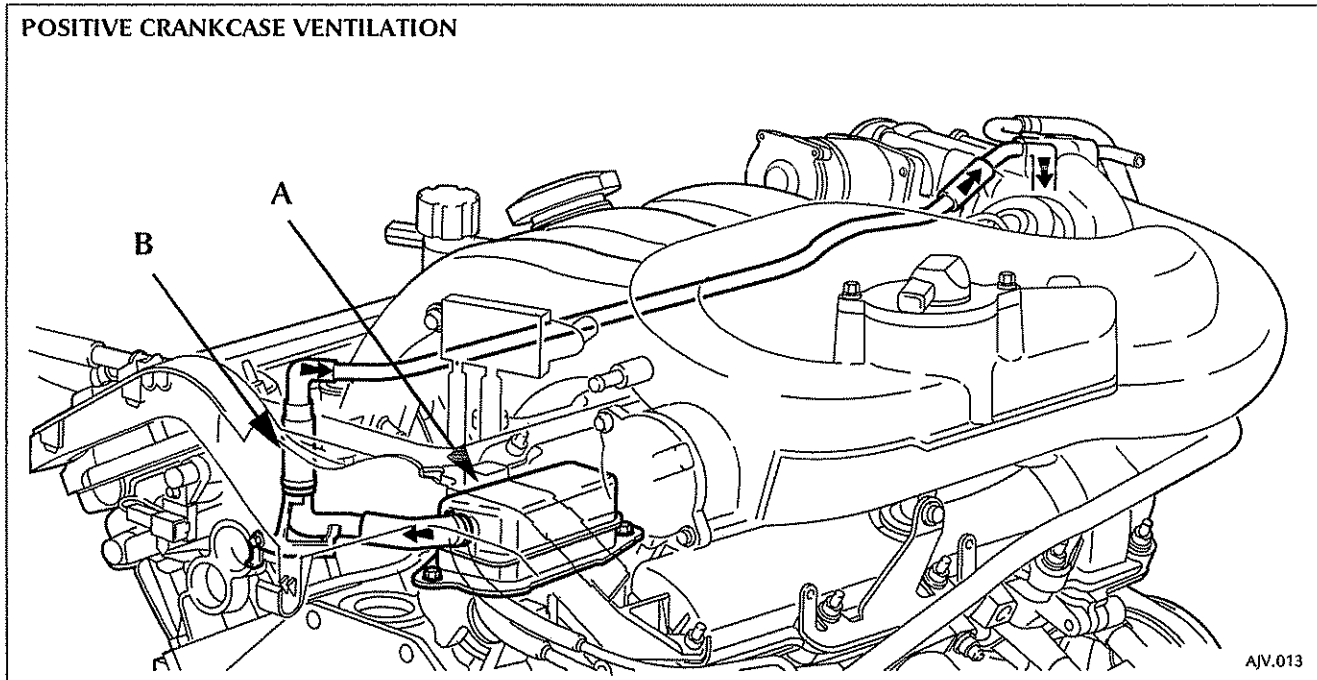
FULL LOAD VENTILATION



AJV.012

Positive Crankcase Ventilation

Under closed or near closed throttle conditions, engine breathing is mainly via the positive crankcase ventilation (PCV) system. An oil separator (A) is bolted to the top of the engine block between the cylinder banks and has an outlet connected to the intake manifold via an in-line PCV valve and hoses. The PCV valve (B) has a spring loaded plunger which opens under the intake vacuum created at low throttle openings. When the PCV valve is open, crankcase gases are drawn through the separator, depositing oil droplets on an internal baffle for return to the sump.

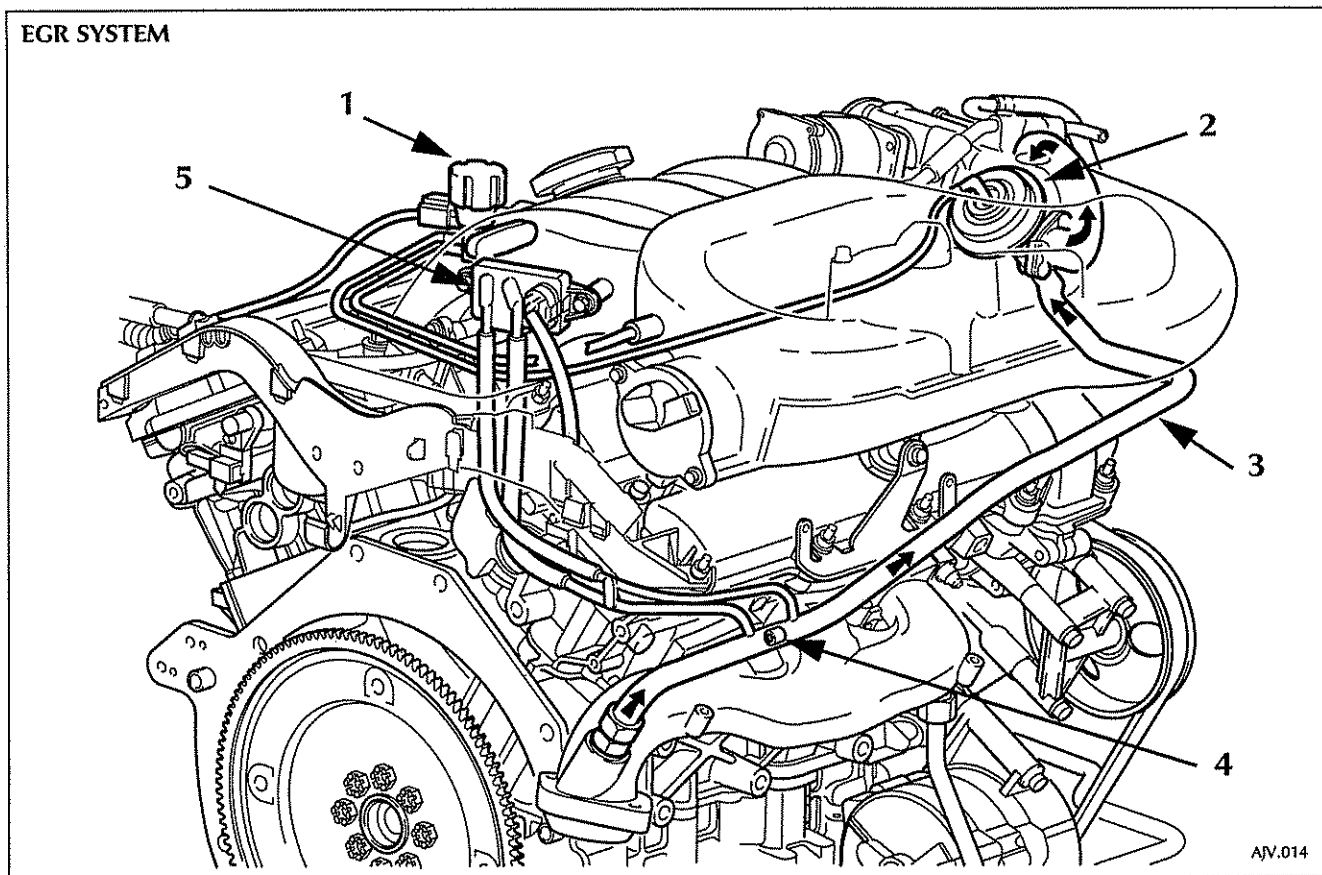


Exhaust Gas Re-Circulation (EGR)

Operation

The EGR system is only fitted to vehicles in NAS markets and comprises the following components:

1. EGR vacuum regulator valve
2. EGR valve
3. Exhaust gas feedback pipe
4. Internal orifice
5. Differential pressure feedback EGR sensor



Exhaust gas is re-circulated back to the engine intake in proportion to a measured pressure differential in the feedback pipe. The amount of gas re-circulated varies primarily with engine speed and load but is also modified by the EMS to allow for other factors, e.g. coolant temperature, and also to achieve optimum emissions and fuel economy.

The re-circulated exhaust gas is taken from the right hand bank exhaust manifold and fed into the engine via the EGR valve. The feedback pipe contains an internal tube with a small diameter orifice that creates a pressure differential in the feedback pipe. Two small pipes, connected to the feedback pipe each side of the orifice, transmit the pressure differential to the differential pressure feedback EGR sensor.

The sensor consists of a transducer (a vacuum operated variable capacitor) and a processing circuit which converts the input pressure/vacuum value to a corresponding analogue voltage which is sent to the PCM. The differential pressure feedback EGR sensor has a linear response and the variations in exhaust pressure produce outputs in the approximate range 1V-3.5V dc.

The EGR vacuum regulator valve and the EGR valve comprise the actuating components of the control loop. The EGR vacuum regulator valve has a vacuum input from the manifold distribution pipes, a vacuum output to the EGR valve and receives a pulse width modulated (PWM) signal from the PCM. The PWM signal switches the vacuum control output to the EGR valve according to input demand from the differential pressure feedback EGR sensor or in response to override conditions determined by the engine management system. The EGR valve is a vacuum operated diaphragm valve with no electrical connections which opens the EGR feed pipe to the induction manifold under the EGR vacuum regulator control.

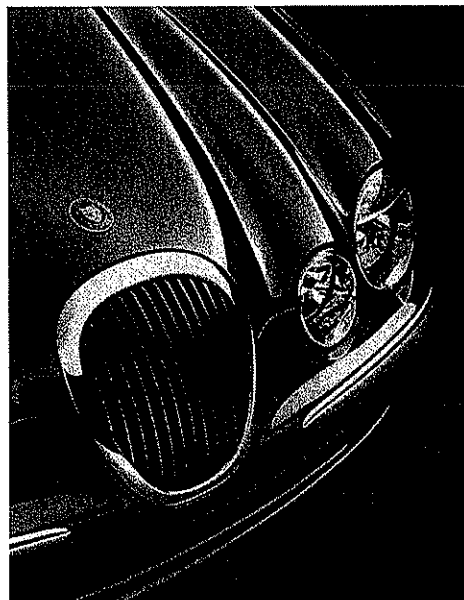
Where the EGR system is not fitted, a blanking plate seals the manifold in place of the EGR valve.

Control Conditions

EGR operates over most of the engine speed/load range but is disabled by the engine management system under certain conditions:

- during engine cranking
- until normal operating temperature is reached
- when the diagnostic system registers a failure which affects the EGR system (e.g. a faulty sensor)
- during idling to avoid unstable or erratic running
- during wide open throttle operation
- when traction control is operative.

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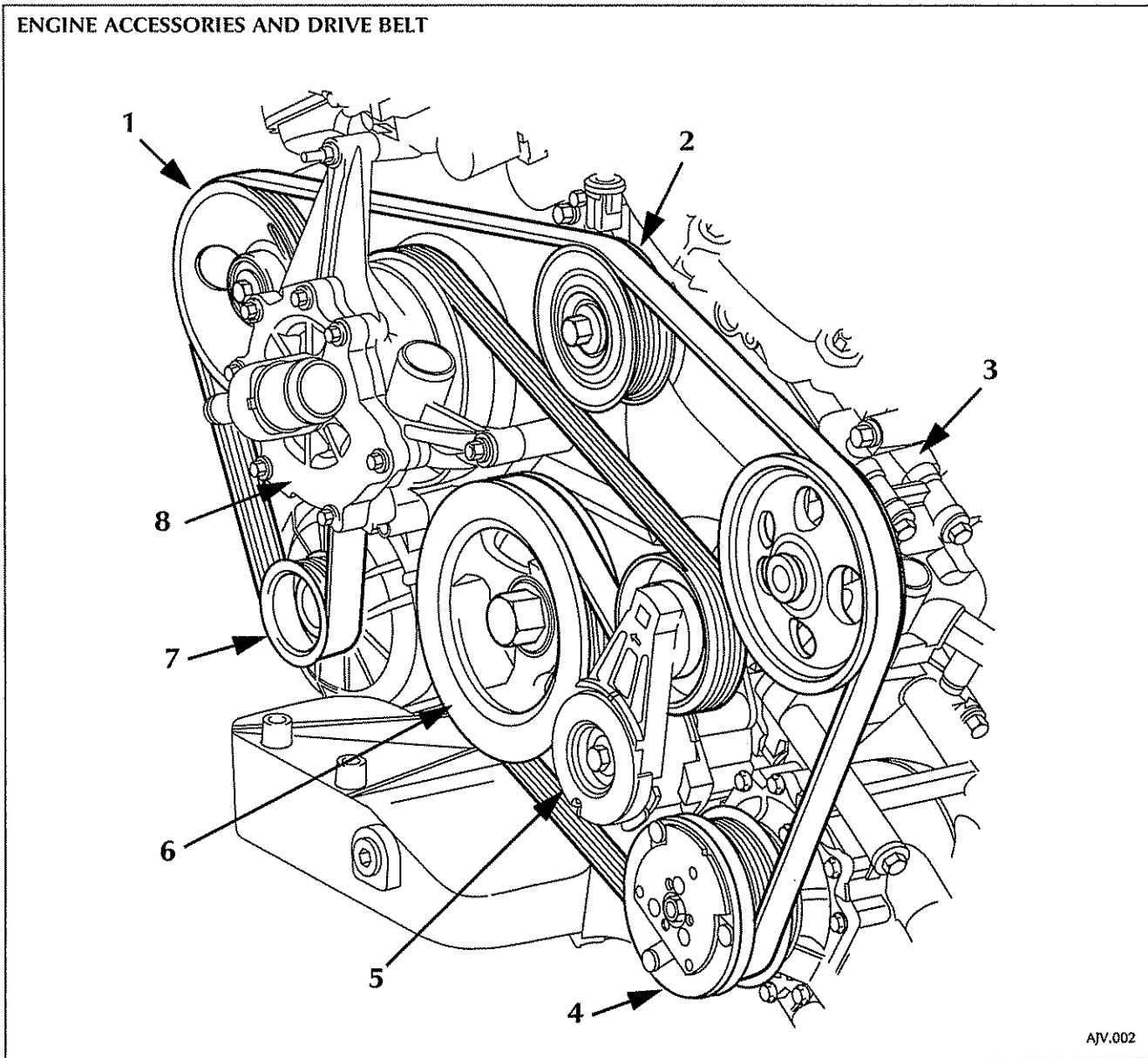
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ENGINE ACCESSORIES AND DRIVE BELT



AJV.002

- | | |
|-------------------|-----------------------------|
| 1. Idler pulley | 5. Drive Belt Tensioner |
| 2. Idler pulley | 6. Crankshaft Damper Pulley |
| 3. PAS Pump | 7. Generator |
| 4. A/C Compressor | 8. Coolant Pump |

Drive Belt

A single six ribbed belt is driven from the crankshaft damper pulley to drive the coolant pump, generator, PAS pump and A/C pump. The drive belt run is guided via two idler pulleys and an automatic belt tensioner.

Idler Pulleys

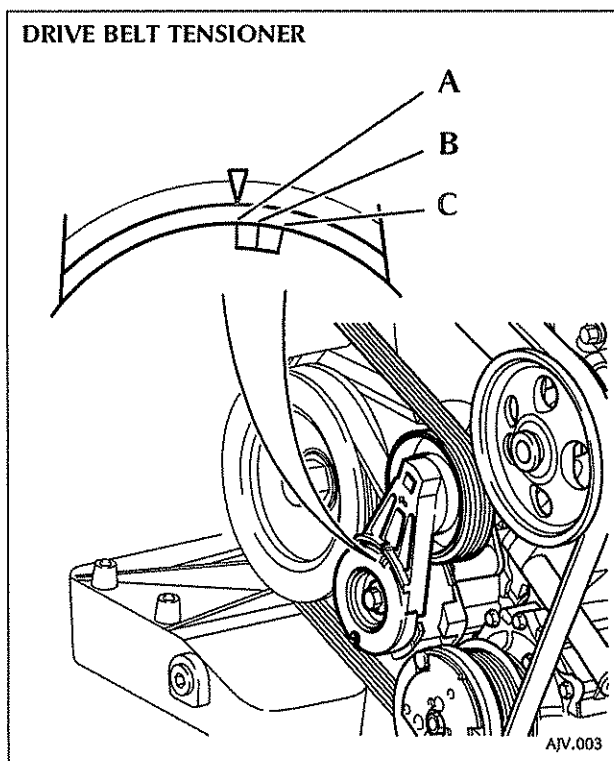
Two idler pulleys are used. One is fixed by a single bolt to the front cover and a second fixed via a mounting bracket to the upper RH side of the cylinder head and front cover.

PAS Pump

The PAS pump is fixed by a single bolt to the LH cylinder head and by two bolts to the front cover. The pulley is constructed of lightweight phenolic material.

Air Conditioning Compressor

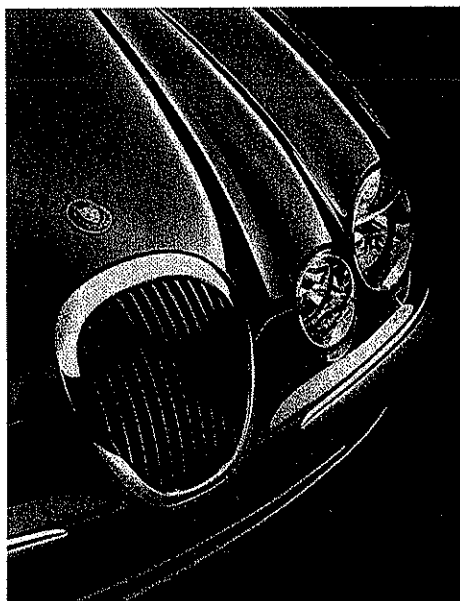
The A/C compressor is mounted on the lower LH side of the engine and is secured by two bolts to a bracket fixed to the bedplate and by two lower bolts directly to the oil sump.



Drive Belt Tensioner

The drive belt tensioner is a similar type to that fitted to the V8 engines. An index on the tensioned arm rotates with wear against three markings on the tensioner spring cap which indicate the minimum (A) and maximum (B) lengths for a new belt and the point at which the belt must be replaced (C).

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FAULT DIAGNOSTICS

Methods of Testing Engine to Diagnose the Condition and Areas of Concern

The tests that can be carried out are:

1. Compression Test.
2. Cylinder Leakage Test.
3. Vacuum Test.

Before performing any of the above tests make sure that the ignition and fuel system are in good condition.

Compression Testing

The amount of compression generated in each cylinder has a great effect on the power output of an engine. Likewise, the amount of compression depends on how well the cylinder is sealed by the cylinder head gasket, piston rings, valves and the gasket. A leak at any of these points will result in a loss of compression and poor driveability. A compression test measures the compression in each individual cylinder. It also points out any significant pressure variations between all of the cylinders.

Preparing for the Test

1. Run the engine until it reaches its normal operating temperature.
2. Disconnect fuel pump relay - depressurise fuel system.
3. Disconnect on-plug coils - label up for quick identification when refitting.
4. Remove on-plug coils.
5. Use compressed air to clean all dirt and other foreign matter out of the spark plug wells.
(NOTE SAFETY GLASSES MUST BE WORN).
6. Remove spark plugs, examine and label up from which cylinder they have been removed.

AT THIS POINT YOU HAVE TO DECIDE WHETHER YOU ARE DOING A WET OR DRY TEST.
7. For a wet test, see the heading 'Wet Compression Test' below. Fit the gauge to the car. **(MUST BE CAPABLE OF RECORDING THE REQUIRED FIGURE PLUS A SAFETY MARGIN.)**

8. Holding the throttle fully open, crank the engine keeping an eye on the compression gauge needle.
9. Record the first and fourth gauge readings. The needle should rise steadily with each subsequent stroke.
10. Open the vent valve to release the compression pressure.
11. Repeat the procedure for the remaining cylinders.

Interpreting Results of Dry Compression Test

- If any reading is low on the first stroke, but gradually gets higher without reaching the specified pressure, the piston rings are probably badly worn.
- If any reading is low on the first stroke and gets only a little higher during subsequent strokes, the cause may be a sticking or burned out valve.
- If the reading is equally low on two adjacent cylinders, the probable cause is a leaking head gasket.
- If the total gauge reading is higher than specified, excessive carbon deposits in the combustion chamber are a likely cause.
- Any cylinders that record a low pressure reading should be given a wet compression test.

Wet Compression Test

- Squirt approximately 5cc of engine oil into the spark plug hole.
- Turn the engine over several times to allow the oil to work its way down around the rings.
- Connect the compression gauge to the cylinder and test as previously (paragraphs 7 to 11).

Interpreting Results

- If the readings are now normal or very close to normal, either the rings, pistons or cylinder bores require attention.
- If the readings do not improve at all, then the leakage is probably at the valves or cylinder head gasket.
- If there is a slight improvement then both of the above areas should be inspected.

Cylinder Leakage Test

While the compression test gives a good indication of the amount of pressure in the cylinders, the leakage test provides a more accurate method of testing the engine condition. Even minute leaks in the valves, rings, or head gasket can be detected.

The leakage test also points out leaks around the exhaust and intake valves, leaks between cylinders, leaks into the water jacket and any other cause of compression loss.

Leakage Tester

The leakage tester contains a precision gauge for extremely accurate readings. Its scale ranges from zero to 100%; zero means that the cylinder is perfectly sealed, 100% indicates that it is not holding any air. To receive a reading as accurate as possible, the gauge should be calibrated before every test. To do this, first turn the control knob anticlockwise until it rotates freely. Connect a 70-200 PSI air supply to the testers air input fitting. Turn the knob until the gauge reads zero. Connect and disconnect a test adapter to the testers cylinder connection fitting. The gauge should rise to 100%, then return to zero; if not the control regulator knob must be adjusted.

Performing the Test

1. Check the coolant level - fill as required.
2. Run the engine to normal operating temperature.
3. Remove the on-plug coils and mark up respectively.
4. Use compressed air to clean out all dirt and other matter from the spark plug wells.
5. Remove all the spark plugs, inspect and mark up respectively.
6. Remove the crank-case breather pipe.
7. Fit the adapter to the spark plug hole.
8. Rotate the engine until that cylinder is at TDC using the crankshaft pulley nut in normal direction of rotation.
9. Once that cylinder is at TDC, use the crank pulley tool to stop the crankshaft rotating.
10. Connect air line to adaptor, allow air into cylinder, read gauge indicator needle.
11. Record the results.
12. Carry out the same procedure for the remaining cylinders.

CAUTION:

The crank tool must be used to stop unexpected crankshaft movement.

**SAFETY GLASSES MUST BE WORN
WHEN USING AIR LINES**

Interpreting Results

All gauge readings taken should be approximately 20%. Any reading of 30% or more indicates a definite problem. Use a hydoscopic leak detector and the following guidelines to determine where the leak is and its cause:

- Air escaping from the exhaust pipe means that an exhaust valve is not sealing.
- Air escaping through the inlet manifold means that an inlet valve is not sealing.
- Air bubbles in the header tank indicate a crack in the block, porous head or a leaking head gasket.
- Leakage from two adjacent cylinders might also indicate a cracked block, head or a leaking head gasket.
- Crankcase leakage could mean worn piston rings or cylinder walls, or a cracked piston. If the engine is relatively new, the problem could just be that the piston rings are not sealing.

In many cases it is useful to compare results of compression and cylinder leaking tests in order to best analyse difficult or unusual mechanical engine problems. For example, an older engine where the compression pressure is acceptable but has air escaping from the crankcase opening is showing signs of old age. High mileage engines typically suffer from excessive blowby and poor fuel consumption, as well as heavy carbon deposits in the combustion chambers. These deposits can raise the compression readings, thus creating the impression that the engine is more mechanically sound than it is.

Low compression combined with minimal cylinder leakage usually means a valve related problem. Incorrect valve timing could also cause this result. The valves are not opening and closing at the correct time in the engine cycle.

Vacuum Testing

An engine vacuum test is one of the quickest and easiest ways to test an engine. Since any piston driven engine is basically a combination vacuum pump and heat exchanger, it is the higher pressure on the outside of the cylinders that cause air to be pushed into the cylinders. When an engine loses the ability to create this pressure differential, its performance suffers.

CAUTION:

Like compression and leakage tests, vacuum testing alone should not be used to locate the exact source of a problem. Always perform it as part of a series of diagnostic tests.

The vacuum gauge reads in increments of inches of mercury (inHg) or millimetres of mercury (mmHg) and has a range of zero to 30inHg or zero to 1000mmHg.

The 'normal' range on a petrol engine is 18-20"Hg (450-500mmHg), with most of today's emission controlled cars falling into the lower end of this scale.

It is important to keep in mind that all vacuum gauge readings depend on altitude: for every 1000ft (305m) above sea level, the reading will fall by 1inHg (25mmHg), so consider sea level when taking a reading.

Performing the Test

1. Use a length of hose to connect the vacuum gauge to a non-restricted port on the inlet manifold. The hose should be at least 3 feet (1 metre) long in order to dampen any vibrations from the needle.
2. In some cases, it may be necessary to further dampen the needle by clamping the hose, slightly restricting its passageway.
3. Run the engine to normal operating temperature.
4. With the engine at idle the needle should be constant between 18-20inHg (450-500mmHg).

Cranking Vacuum Test

1. Run engine to normal operating temperature.
2. Depressurise the fuel system and ignition system.
3. Crank the engine - note the vacuum reading. An engine in good condition should produce at least 5inHg (125mmHg).
4. If the reading is less check the inlet manifold for leaks or a split vacuum pipe.

Exhaust System Test

1. Run the engine to normal operating temperature.
2. Accelerate the engine slowly. After it reaches 2000rpm, not the reading on the gauge; it should drop a little, then rise sharply.
3. Close the throttle quickly. The needle should return to the normal idle reading as quickly as it rose.
4. If the needle gives a normal reading at idle speed, and at 2000rpm drops to near zero, and rises to a below normal reading, there is a restriction in the exhaust system.
5. Drive the car until it reaches the speed where the engine loses power. The gauge reading should be approximately the same each time a power loss occurs with the needle dropping towards zero. The greater the restriction, the closer to zero the needle will drop.

Vacuum Testing for Loss of Compression

A vacuum gauge can be used to test for compression loss due to leakage around the pistons. This test should not be performed unless normal readings were produced on all previous vacuum tests.

1. Make sure that the oil is in good condition.
2. Connect vacuum gauge.
3. Quickly accelerate the engine to 2000rpm, then close the throttle fast.
4. As the throttle closes, the needle should rise 5 inches Hg or more above the normal reading. An increase of less than 5inHg (125mmHg) means there is a compression loss around the pistons, rings, or cylinder walls.

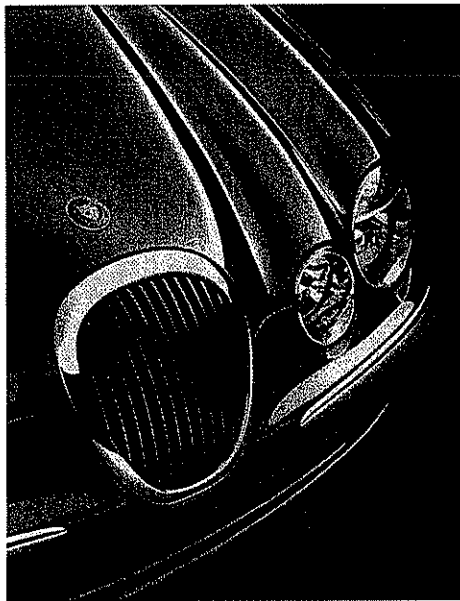
Understanding Compression Ratios

The compression ratio measures how much the volume of the cylinder is reduced by the piston as it travels from bottom dead centre (BDC) to top dead centre (TDC). When the piston is at TDC this is known as the clearance volume. In other words, the compression ratio is simply, the total volume of the cylinder divided by the clearance volume. For example, if the total cylinder volume is 500cc and the clearance volume is 50cc, the compression ratio is $500/50 = 10:1$.

The higher the compression ratio, the greater the engine torque and horsepower. The piston forces the air/fuel mixture into a smaller area, which increases the combustion pressure in the engine.

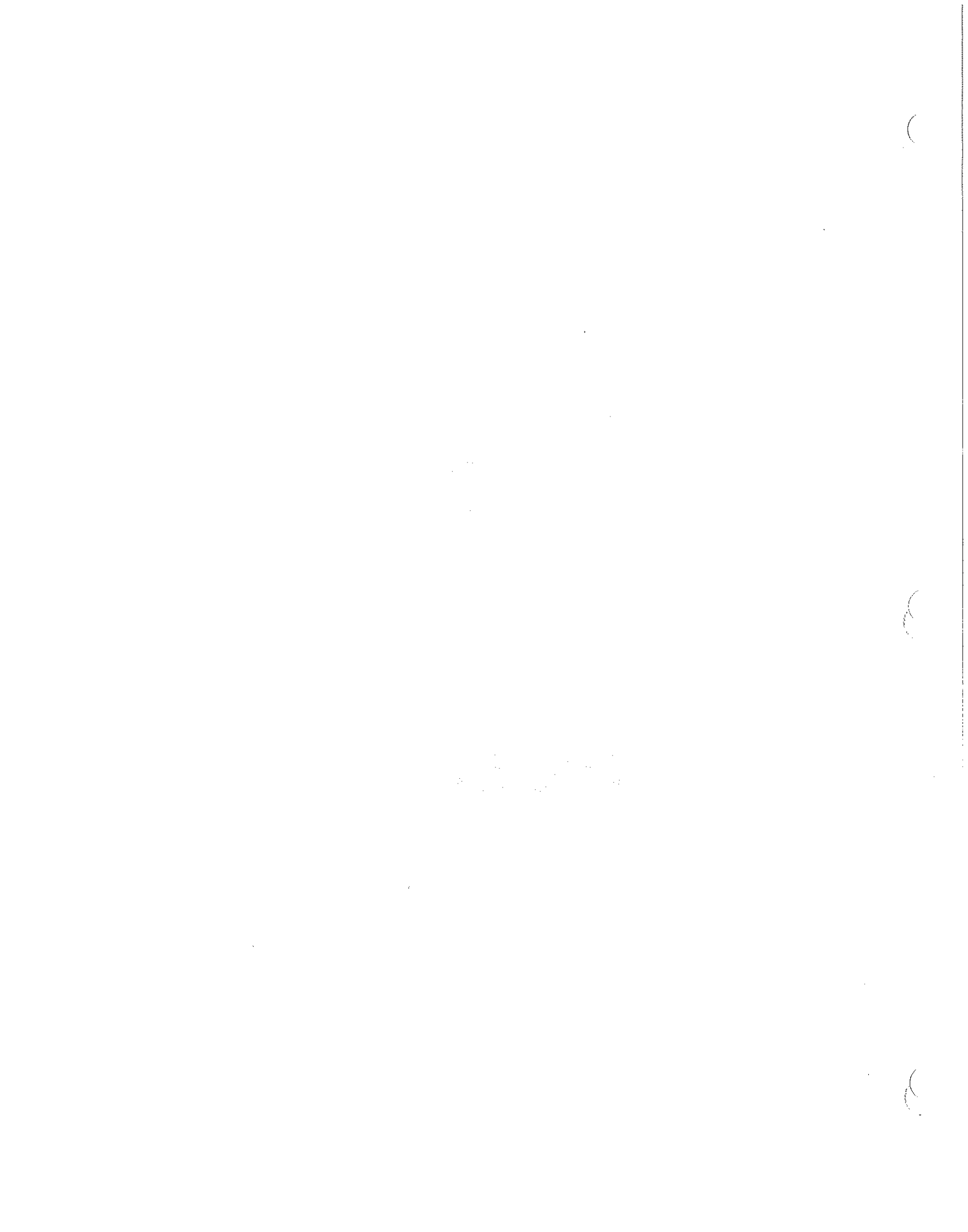
An engine with an 8:1 compression ratio has a compression pressure of approximately 150 PSI and a combustion pressure of 600 PSI; in comparison, an engine with a 7:1 compression ratio has a compression ratio, has a compression pressure of about 125 PSI and a combustion pressure of 500 PSI.

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Technician Name: _____

Instructor: John Adrey Date: 10-16-09

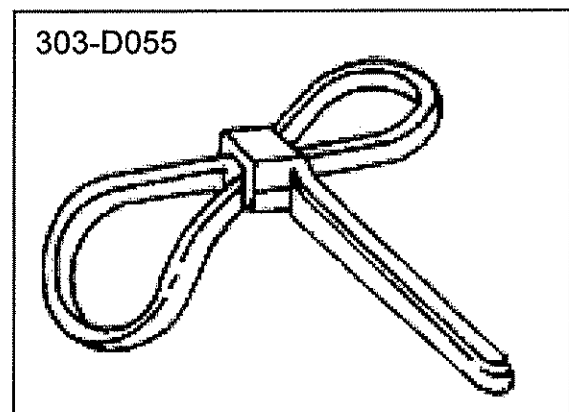
This worksheet is a guide to the **disassembly** of the AJ V6 engine. Follow and complete each step in sequence. Check off each group of steps as completed.

When you reach an INSTRUCTOR CHECK POINT, call your instructor who will examine your work and issue further instructions.

Do not continue past an INSTRUCTOR CHECK POINT unless instructed.

Inspect components during disassembly and note any problems found on the worksheet.

- 1. Disconnect harness fixings - work around from B bank to A bank. Disconnect fuel injector harness. Allow harness to rest at the idler pulley at front of A bank.
- 2. Slacken belt tensioner, remove serpentine belt.
- 3. Remove idler pulley assemblies from "A" bank.
- 4. Remove intake manifold bolts and upper manifold.
- 5. Remove lower manifold with injectors (observe gasket fittings to familiarize re-assembly)
- 6. Remove ignition coils.
- 7. Remove cam covers.
- 8. Remove water pump (note water pump outlet hose has both a constant pressure and a back up traditional hose clamp to ensure sealing). The constant pressure hose clamp is bonded to the hose (do not twist), relieve tension with pliers and pry hose from barb.
- 9. Remove: Power steering pump, AC compressor, belt tensioner, B bank idler pulley and generator (alternator).
- 10. Remove exhaust manifolds
- 11. Remove flex plate. Flex plate removal is achieved with special tool **303-D055** to hold damper pulley while loosening flex plate bolts.



INSTRUCTOR CHECK POINT 1: _____

□ 12. Locate and record the following data codes:

Engine Number 1430FO415

Emission ID Label 16431A4

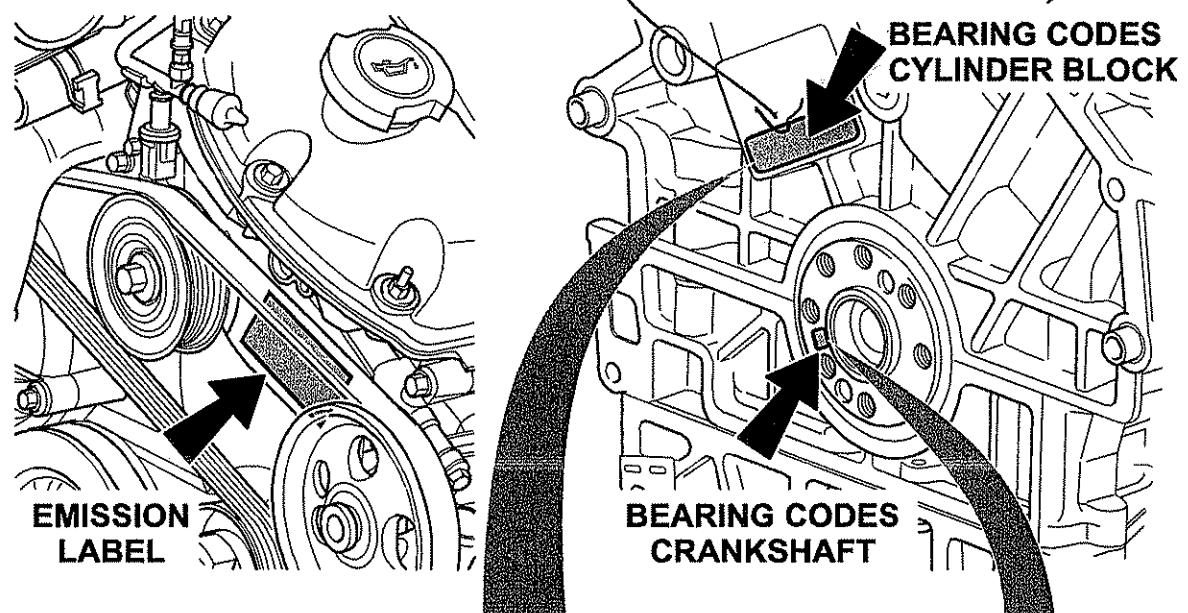
Crankshaft Main Bearing Journal Codes: 1. 79 2. 81 3. 82 4. 84

Cylinder Block Main Bearing Journal Codes: 1. 06 2. 05 3. 07 4. 08 Z=3.0

Cylinder bore/Piston Grade Codes:

- A Bank
- B Bank

1. 0 2. 0 3. 9 1 = 2.5
 N = North
 S = South



0609*0711
B2122222

8480*8082

Bearing Selection 2,2,2,1

INSTRUCTOR CHECK POINT 2: [Signature]

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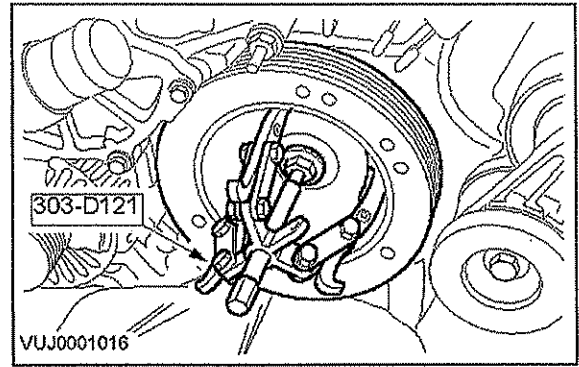
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- 13. Remove vibration damper bolt and washer. Reinstall bolt as a press surface for the vibration damper with special tool **303-D121**. Remove vibration damper.
- 14. Remove front timing case cover oil seal
- 15. Remove oil pan and timing case cover.



INSTRUCTOR CHECK POINT 3: _____

Hylosil on "T" unions,

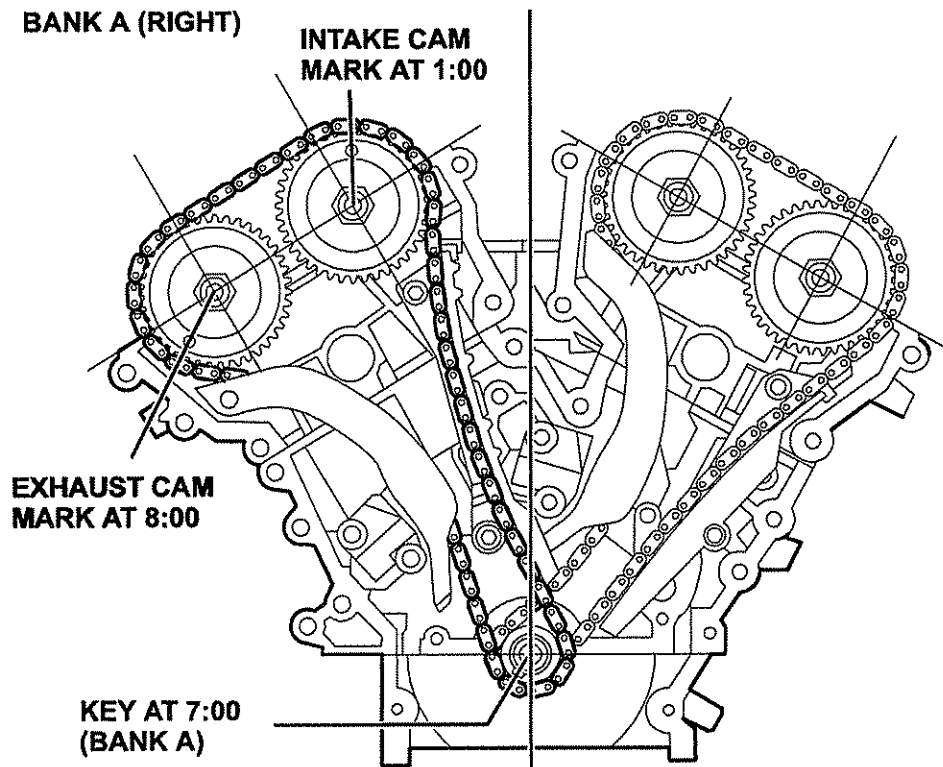
Some V-6 Belts are wheel - key way w/ missing

"A" Bank (Right) Chain Removal

- 16. Starting with the A bank (right) set camshaft timing to crankshaft reference.
- 17. Rotate crankshaft so the key way is at the 7 O'clock position.

tooth for clamps

TREAT EACH BANK AS A SEPARATE ENGINE



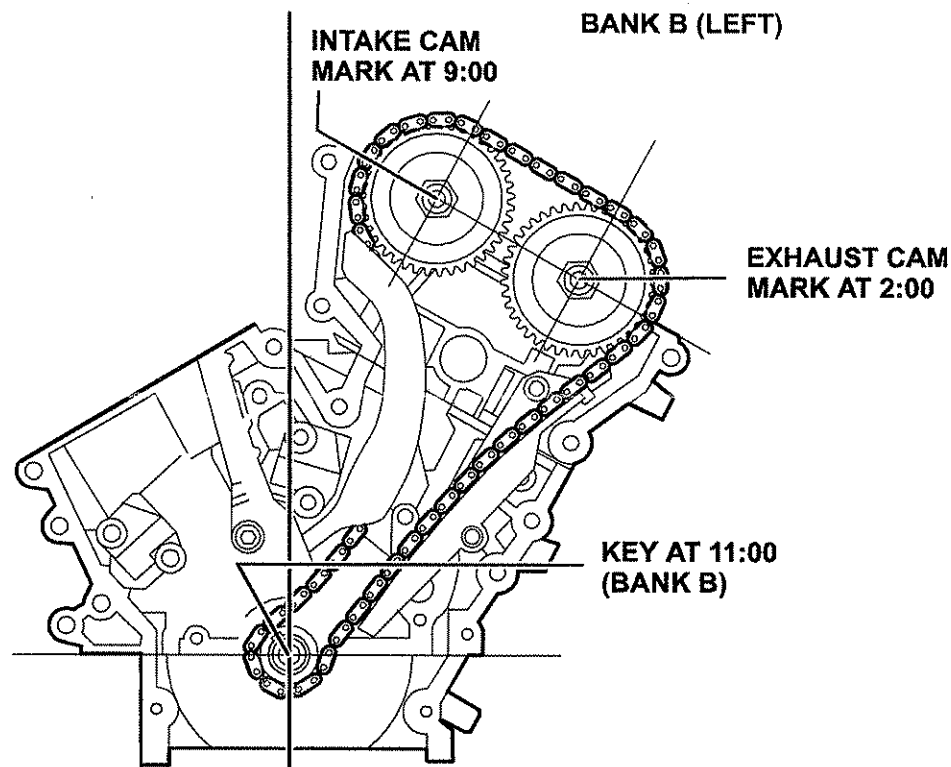
*10R
9R
8R
7R
6R
5R
4R
3R
2R
1R*

- 18. Ensure the camshafts are in safe position (no valves open), if they are not, rotate crankshaft one full turn clockwise. The camshaft marks should be at approximately 1:00 o'clock position for the intake and 8:00 o'clock position for the exhaust.
- 19. After removing the right hand tensioner and guide remove the chain. Note the stamped camshaft bearing cap codes and remove. Remove the camshafts and buckets noting their positions, then remove the cylinder head.

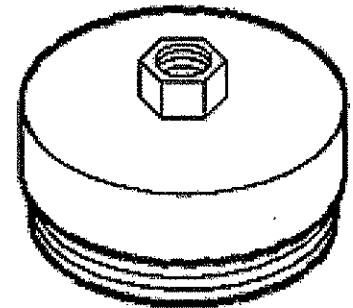
"B" Bank (Left) Chain Removal

- 20. Rotate crankshaft clockwise so the key way is at the 11 O'clock position.

TREAT EACH BANK AS A SEPARATE ENGINE

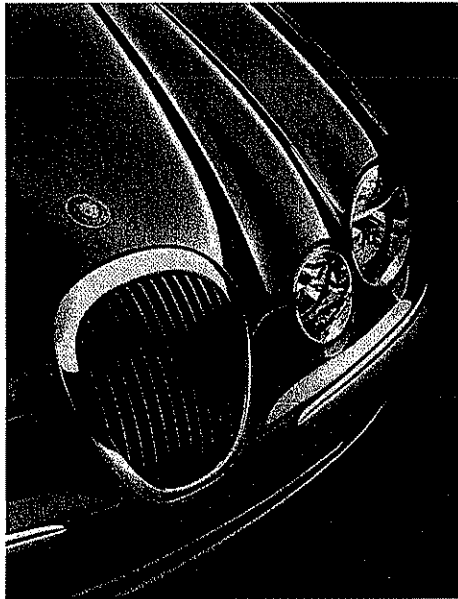


- 21. Ensure the camshafts are in safe position (no valves open), if they are not, rotate crankshaft one full turn clockwise. The camshaft marks should be at approximately 9:00 o'clock position for the intake and 2:00 o'clock position for the exhaust.
- 22. After removing the left hand tensioner, guide and chain, remove the camshafts and buckets noting their positions, then remove the cylinder head.
- 23. After removing the tensioner, guide and the oil pump, remove all pistons.
- 24. Remove rear main oil seal using tool 303-566.
- 25. Remove block bed plate (observe sealing as shown in illustration below).
- 26. Remove crank and thrust washer.



INSTRUCTOR CHECK POINT 4: _____

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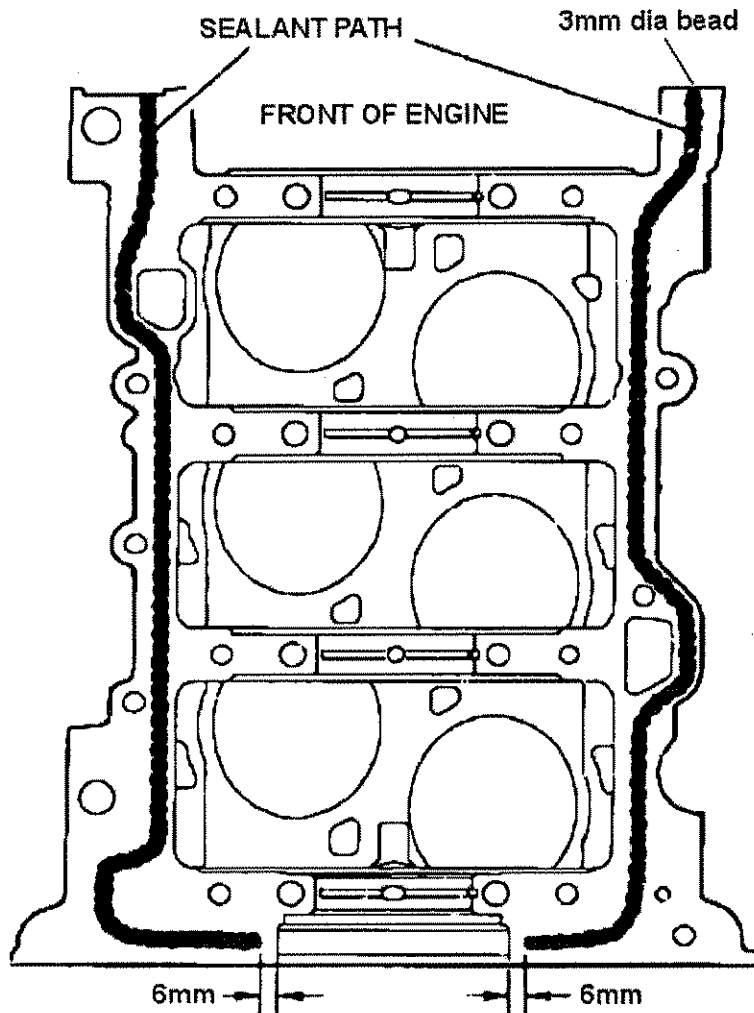
This worksheet is a guide to the **re-assembly** of the AJ V6 engine. Follow and complete each step in sequence. Check off each group of steps as completed.

When you reach an **INSTRUCTOR CHECK POINT**, call your instructor who will examine your work and issue further instructions.

Do not continue past an **INSTRUCTOR CHECK POINT** unless instructed.

Inspect components during disassembly and note any problems found on the worksheet.

- 1. Clean all components prior to installation.
- 2. Install crankshaft and thrust washer.
- 3. Apply bead of sealant as shown in illustration below.



Sealant/Adhesive

Part number	Description
	Silicone rubber, RTV cured, Sealant
	Anaerobic Adhesive

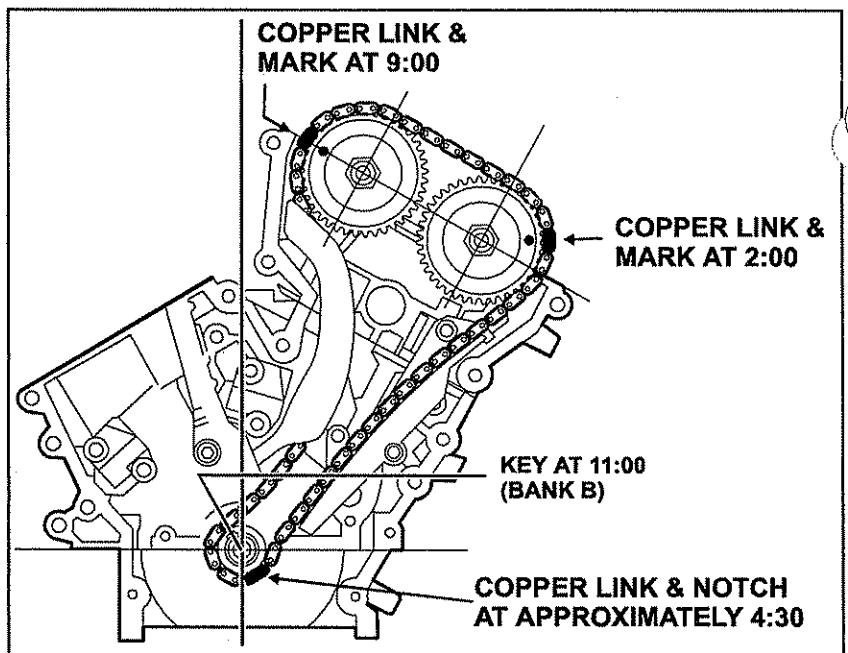
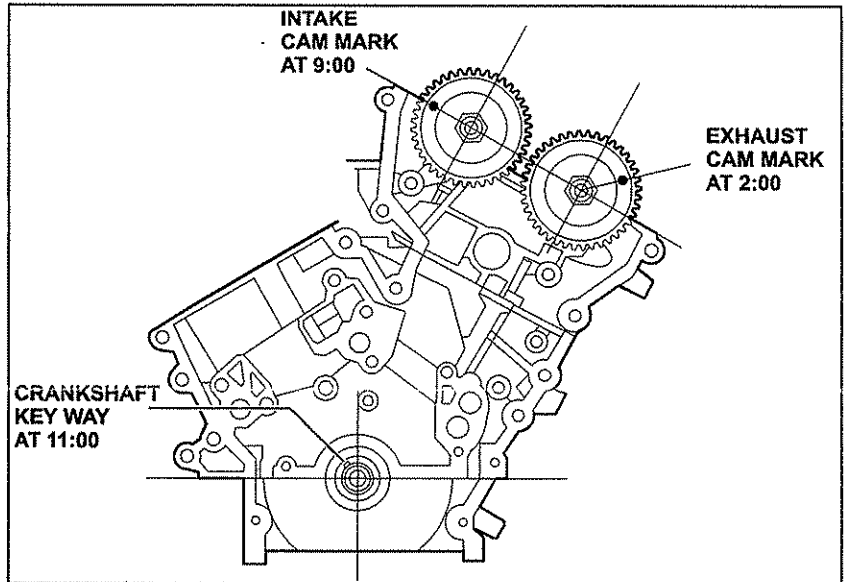
Degreaser/Cleaner

Part number	Description
	Engine Degreaser

- 4. Tighten and torque bolts to spec in proper sequence within four minutes.
- 5. Install all pistons.

"B" Bank Chain Installation

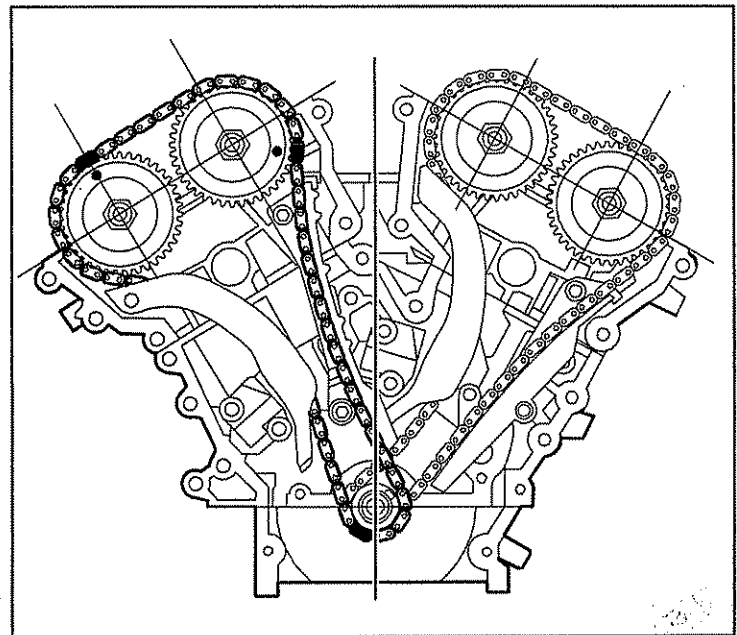
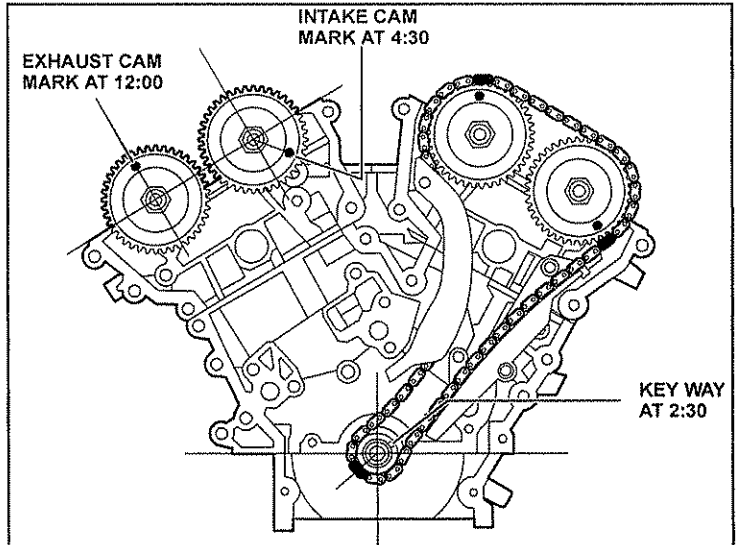
- 6. Position the crankshaft to ensure the key way is in the 11:00 o'clock position.
- 7. Install the B bank cylinder head. Torque value = _____ (Refer to JTIS).
- 8. Place the B bank camshafts into the cylinder head and properly locate the timing marks to the 9:00 o'clock position for the intake and 2:00 o'clock position for the exhaust camshafts.
- 9. Place the camshaft bearing caps onto the left bank camshafts starting with #1 ensuring they are in their correct positions (do not overtighten).
- 10. Fit the left hand chain, ensure all the copper links line up with the marks on the camshaft gears. The third copper link will line up with a notch in the crankshaft gear at approximately 4:30 o'clock with no relation to the key way.
- 11. Fit the guide and tensioner and release.



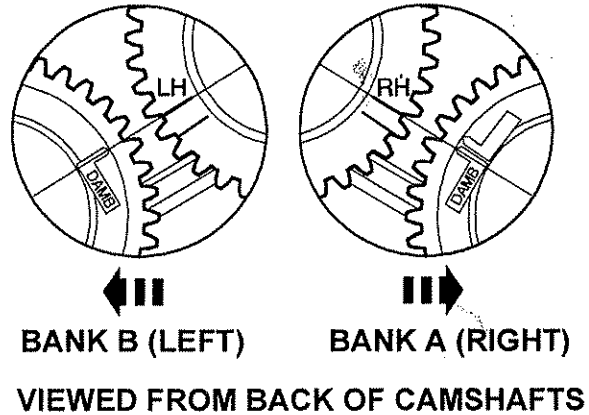
INSTRUCTOR CHECK POINT 5: _____

"A" Bank Chain Installation

- 12. Install the A bank cylinder head.
Torque Value: _____.
- 13. Rotate crankshaft clockwise to align the key way to 2:30 o'clock position as shown in the illustration below.
- 14. Place the right bank (A) camshafts into the cylinder head and properly locate the timing marks to the 4:30 o'clock position for the intake and 12:00 o'clock position for the exhaust camshafts.
- 15. Fit the A bank chain ensuring the copper links line up with the marks on the gears. The third link will line up with the third link of the B bank chain. Fit the guide and tensioner and release.
- 16. Rotate the crankshaft $3 \frac{3}{4}$ rotations to ensure chain seating. The key way should now be at the 11:00 o'clock position (This is TDC).



- 17. Check the back side of the camshaft gears to ensure the timing marks line up.
 - On the left bank (B) camshafts, the acronym "DAMB" (Direct Actuating Mechanical Bucket) line up with the "LH".
 - The right bank (A), "DAMB" must line up with the "RH".



INSTRUCTOR CHECK POINT 6: _____

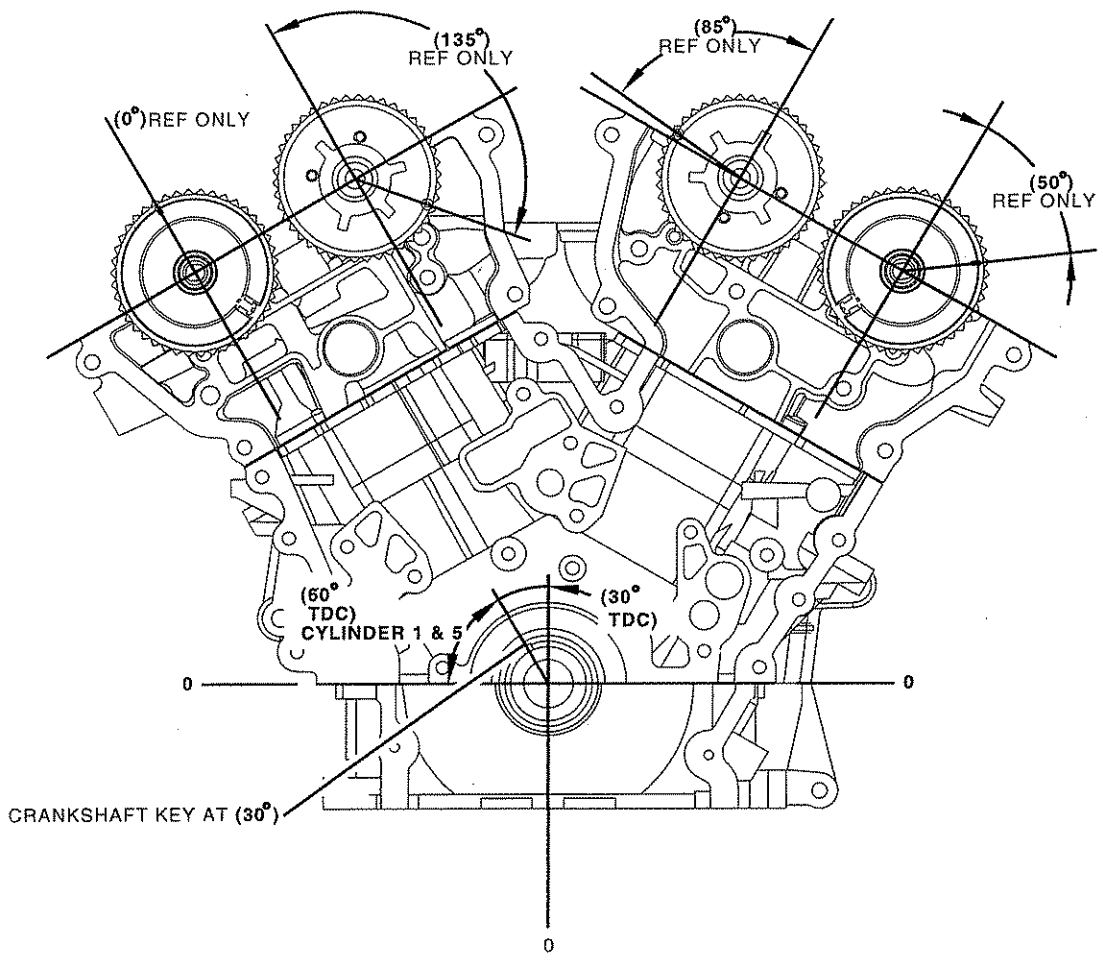
- 18. Install oil pan and timing case cover.
- 19. Install front timing case cover oil seal.
- 20. Install vibration damper.
- 21. Install flex plate. Use special tool **303-D055** to hold damper pulley while tighteng flex plate bolts.
- 22. Install exhaust manifolds
- 23. Install steering pump, AC compressor, belt tensioner, B bank idler pulley and Alternator.
- 24. Install water pump. The constant pressure hose clamp is bonded to the hose (do not twist), relieve tension with pliers and slide hose onto barb.
- 25. Install cam covers
- 26. Install ignition coils
- 27. Install lower manifold with injectors
- 28. Install intake manifold bolts and upper manifold.
- 29. Install idler pulley from "A" bank
- 30. Install serpentine belt (refer to illustration in section 5).
- 31. Connect harness fixings - work around from A bank to B bank. Connect fuel injectors.

CAMSHAFT PRE-ASSEMBLY TIMING MARK ALIGNMENT

X400 _____ SHOWN
DEW03/X203/X350 _____ TYPICAL

NOTE:
TIMING MARK ON VCT
ACTUATOR & SPROCKET
ASY IS WHITE.

1. BEGIN WITH CRANKSHAFT AT (90° (60° BTDC)) (AS SHOWN ON 17B)
2. ENSURE CAMSHAFTS ARE IN NEUTRAL POSITIONS WITH THE TIMING MARKS AS SHOWN.
3. ROTATE CRANKSHAFT (60°) CLOCKWISE TO TDC (AS SHOWN)
4. INSTALL LH CAM DRIVE COMPONENTS.



030901			SECTION - D				
REL	NE01-E11320306-000	MODEL	2003 2.0L / 2.5L / 3.0L-4V DAMB	DATE	020509	LAST FRAME	80
<i>Ford Motor Company</i> V-ENGINE ILLUSTRATION		NO.	IL3W9E-030002-A0543F	REV	---	FRAME	22
						CONTD	22A

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CRANKSHAFT GEAR, TIMING CHAIN, VARIABLE TIMING HOUSING ASY AND TENSIONER ARM ASY (LH)

C21 NOTE:
ZERO TORQUE SEQUENCE
① THEN ② THEN ③
FOR PROPER -6C261-
SEATING

3.0L-4V _____ SHOWN
2.0L/2.5L-4V _____ TYPICAL

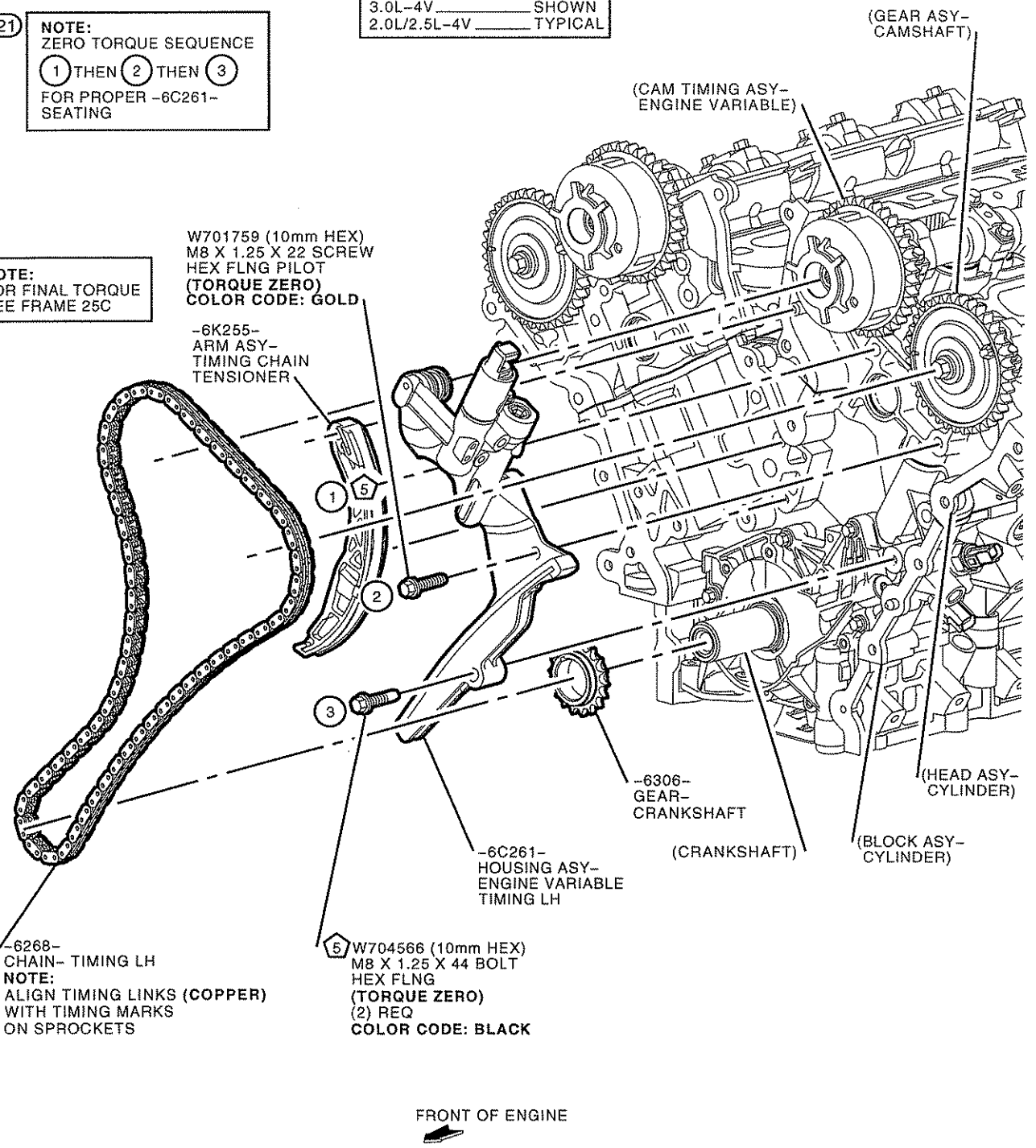
NOTE:
FOR FINAL TORQUE
SEE FRAME 25C

W701759 (10mm HEX)
M8 X 1.25 X 22 SCREW
HEX FLNG PILOT
(TORQUE ZERO)
COLOR CODE: GOLD

-6K255-
ARM ASY-
TIMING CHAIN
TENSIONER

-6268-
CHAIN- TIMING LH
NOTE:
ALIGN TIMING LINKS (COPPER)
WITH TIMING MARKS
ON SPROCKETS

⑤ W704566 (10mm HEX)
M8 X 1.25 X 44 BOLT
HEX FLNG
(TORQUE ZERO)
(2) REQ
COLOR CODE: BLACK



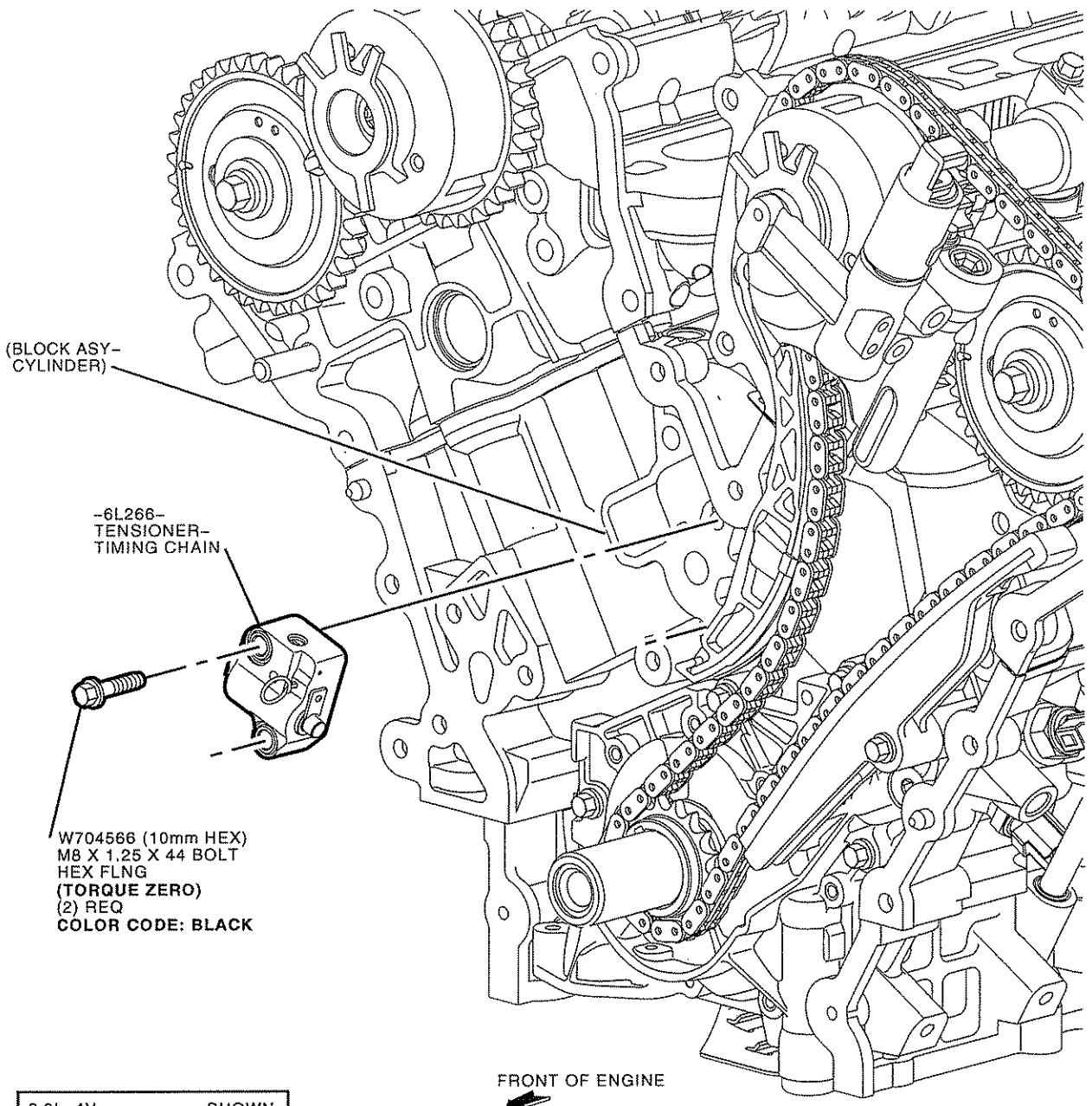
030901		SECTION - D	
REL	NE01-E11433990-000	MODEL	2003 2.0L / 2.5L / 3.0L-4V DAMB
DATE	030217	LAST FRAME	80
<i>Ford Motor Company</i>	V-ENGINE ILLUSTRATION	NO.	IL3W9E-030002-A0543F
REV	C21	FRAME	22A
CONTD			22B

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TIMING CHAIN TENSIONER (LH)



(BLOCK ASY-CYLINDER)

-6L266-TENSIONER-TIMING CHAIN

W704566 (10mm HEX)
 M8 X 1.25 X 44 BOLT
 HEX FLNG
 (TORQUE ZERO)
 (2) REQ
 COLOR CODE: BLACK

FRONT OF ENGINE

3.0L-4V _____ SHOWN
 2.0L/2.5L-4V _____ TYPICAL

NOTE:
 FOR FINAL TORQUE
 SEE FRAME 25C

(C8)

030901					SECTION - D		
REL	NE01-E11433990-000	MODEL	2003 2.0L / 2.5L / 3.0L-4V DAMB	DATE	030217	LAST FRAME	80
<i>Ford Motor Company</i>		V-ENGINE ILLUSTRATION	NO. ∇ IL3W9E-030002-A0543F	REV	C8	FRAME	22B
						CONTD	22C

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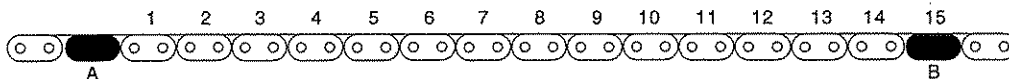
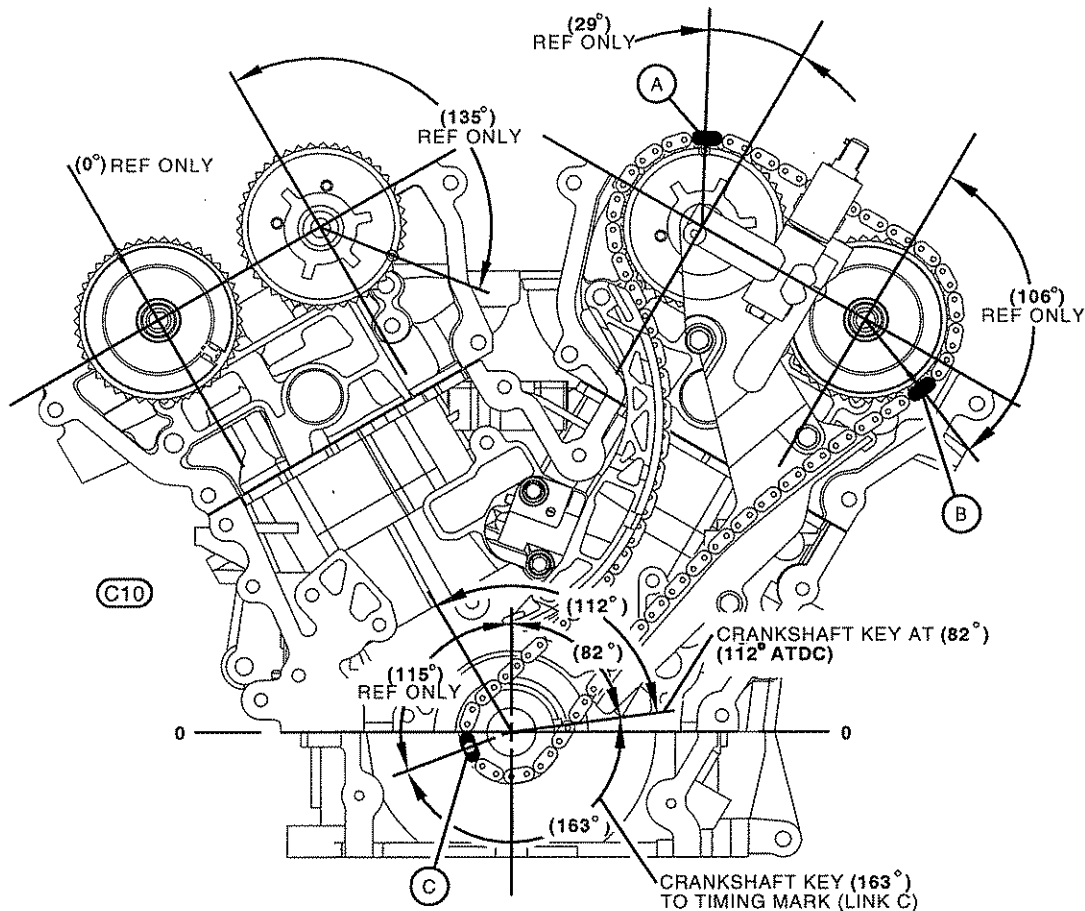
CRANKSHAFT, CAMSHAFT SPROCKETS AND TIMING CHAIN (LH) & (RH) TIMING MARK ALIGNMENT

NOTE:
COPPER LINKS
AT (A), (B) & (C)
POSITIONS

NOTE:
YELLOW MARKS ON LINK
AT (C) POSITION ONLY

1. BE SURE LH CAM DRIVE TENSIONER PIN IS PULLED BEFORE ROTATING CRANK.
2. ROTATE CRANKSHAFT (112°) CLOCKWISE TO (112° ATDC)
3. INSTALL RH CAM DRIVE COMPONENTS.

NOTE:
READY FOR RH CAM DRIVE INSTALLATION
AFTER ROTATING CRANK (112°).



15 LINKS.

2. COUNT WHOLE LINKS CLOCKWISE STARTING WITH THE LINK IMMEDIATELY TO THE LEFT OF LINK (B) (COPPER LINK) & INCLUDE THE NEXT (COPPER) LINK (C) IN THE TOTAL TO ACHIEVE 24 LINKS.

030901

(C9)

SECTION - D

REL NE01-E11433990-000	MODEL 2003 2.0L / 2.5L / 3.0L-4V DAMB	DATE 030217	LAST FRAME 80
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	V-ENGINE ILLUSTRATOR NO. ∇ IL3W9E-030002-A0543F	REV C10	FRAME 22C CONTD 22D
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VARIABLE TIMING HOUSING ASY (RH)

C21

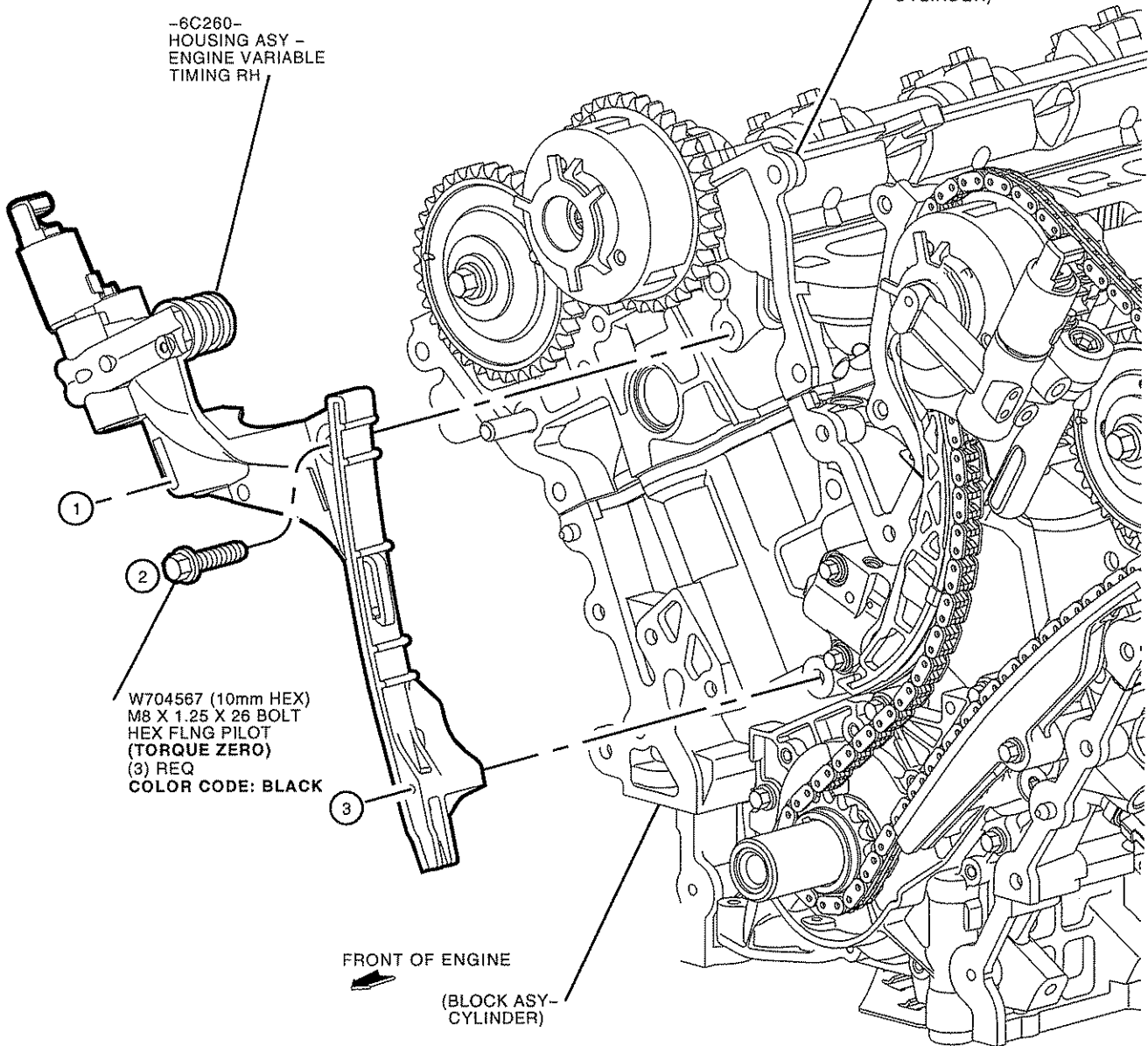
NOTE:
ZERO TORQUE SEQUENCE
① THEN ② THEN ③
FOR PROPER -6C261-
SEATING

3.0L-4V _____ SHOWN
2.0L/2.5L-4V _____ TYPICAL

NOTE:
FOR FINAL TORQUE
SEE FRAME 25C

-6C260-
HOUSING ASY -
ENGINE VARIABLE
TIMING RH

(HEAD ASY-
CYLINDER)



W704567 (10mm HEX)
M8 X 1.25 X 26 BOLT
HEX FLNG PILOT
(TORQUE ZERO)
(3) REQ
COLOR CODE: BLACK

FRONT OF ENGINE

(BLOCK ASY-
CYLINDER)

030901

SECTION - D

REL	NE01-E11433990-000	MODEL	2003 2.0L / 2.5L / 3.0L-4V DAMB	DATE	030217	LAST FRAME	80
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Ford Motor Company	V-ENGINE ILLUSTRATION	NO.	IL3W9E-030002-A0543F	REV	C21	FRAME	22D	CONTD	23

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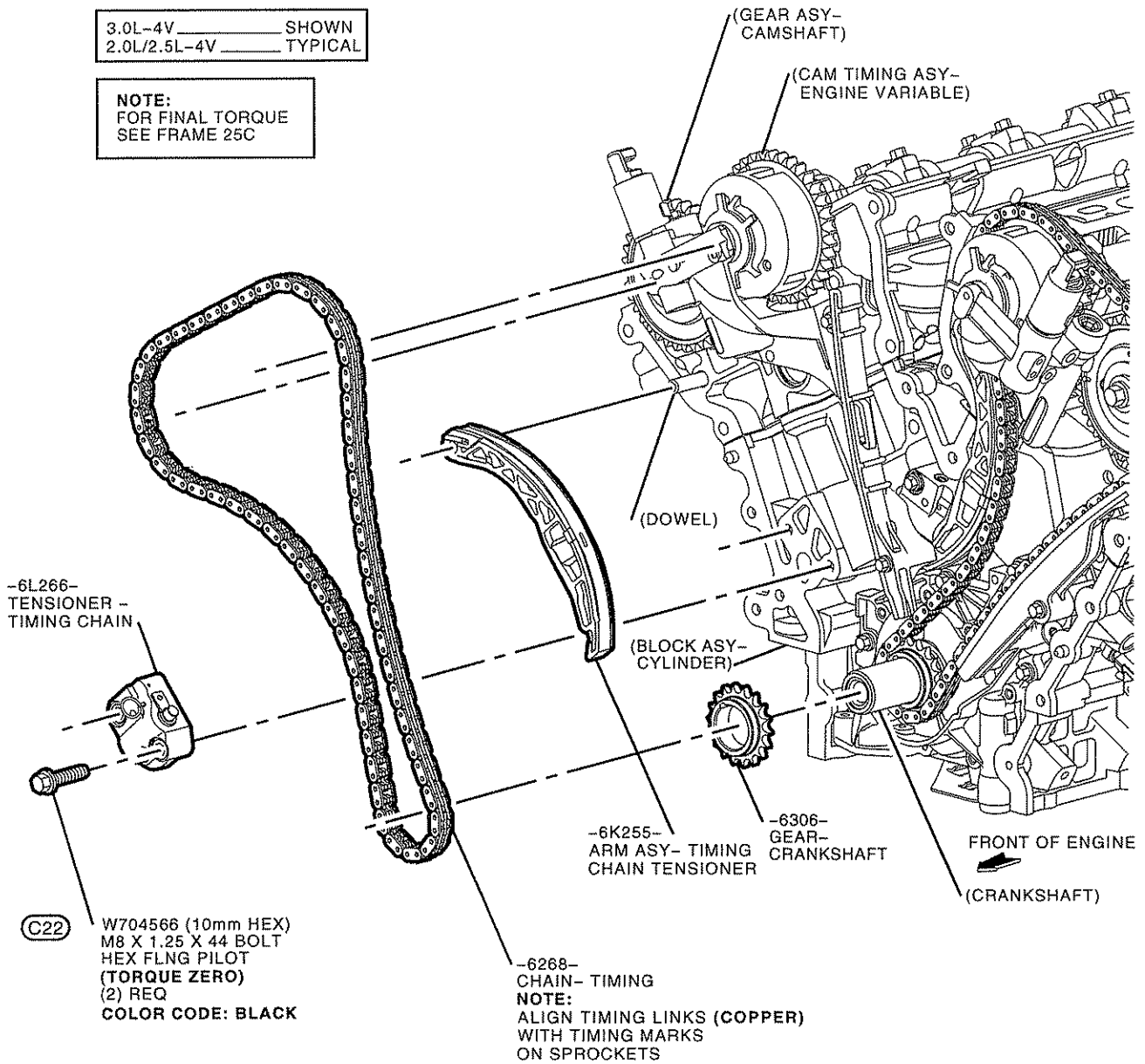
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CRANKSHAFT GEAR, TIMING CHAIN, TENSIONER ARM ASY AND TENSIONER (RH)

3.0L-4V _____ SHOWN
 2.0L/2.5L-4V _____ TYPICAL

NOTE:
 FOR FINAL TORQUE
 SEE FRAME 25C



030901

SECTION - D

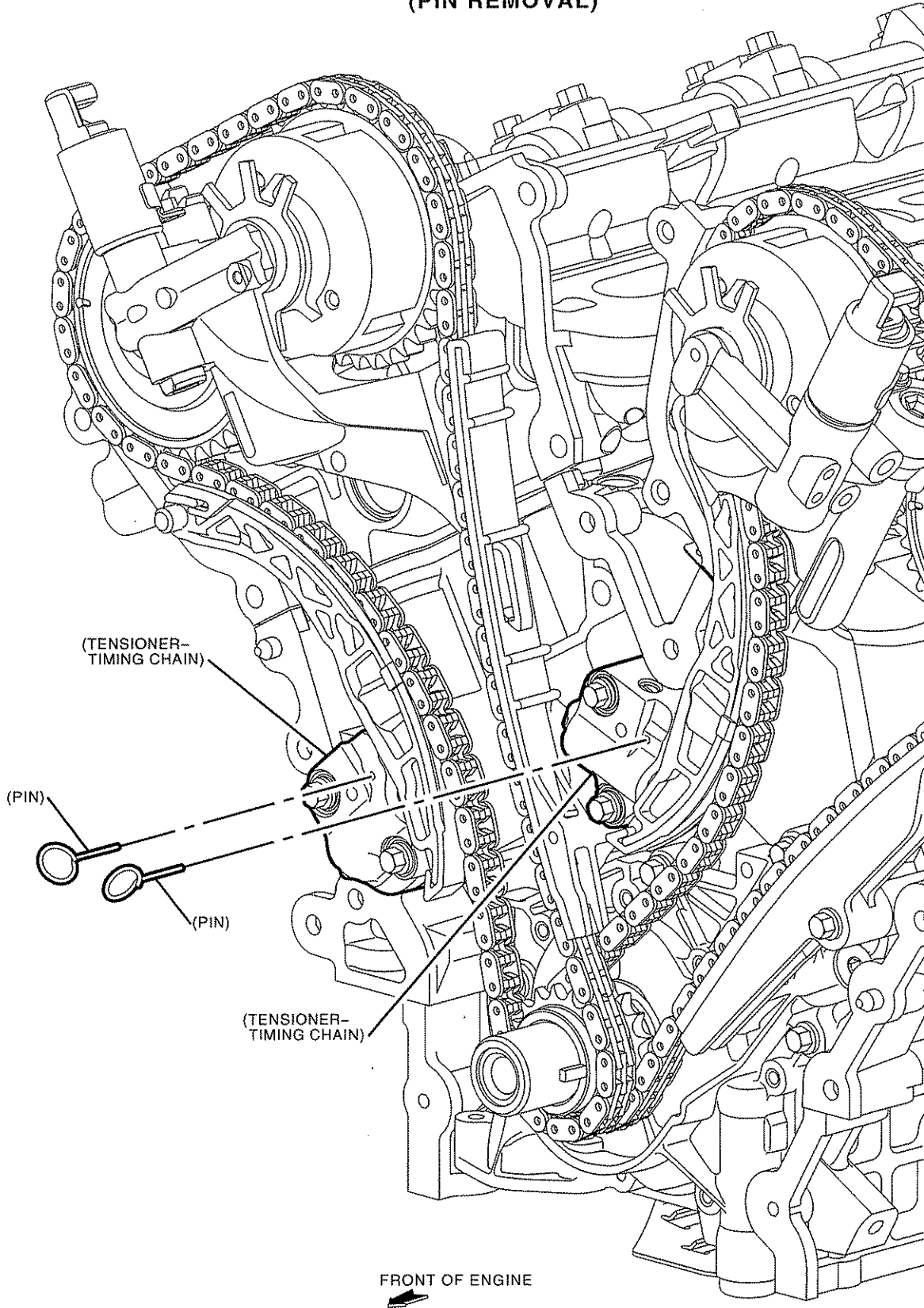
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		V-ENGINE ILLUSTRATOR	NO. ∇ IL3W9E-030002-A0543F	REV	C22	FRAME	25
						CONTD	25A

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TIMING CHAIN TENSIONER (PIN REMOVAL)



030901

SECTION - D

REL	NE01-E11320306-000	MODEL	2003 2.0L / 2.5L / 3.0L-4V DAMB	DATE	020509	LAST FRAME	80
		NO.	IL3W9E-030002-A0543F	REV	---	FRAME	25A
						CONTD	25B

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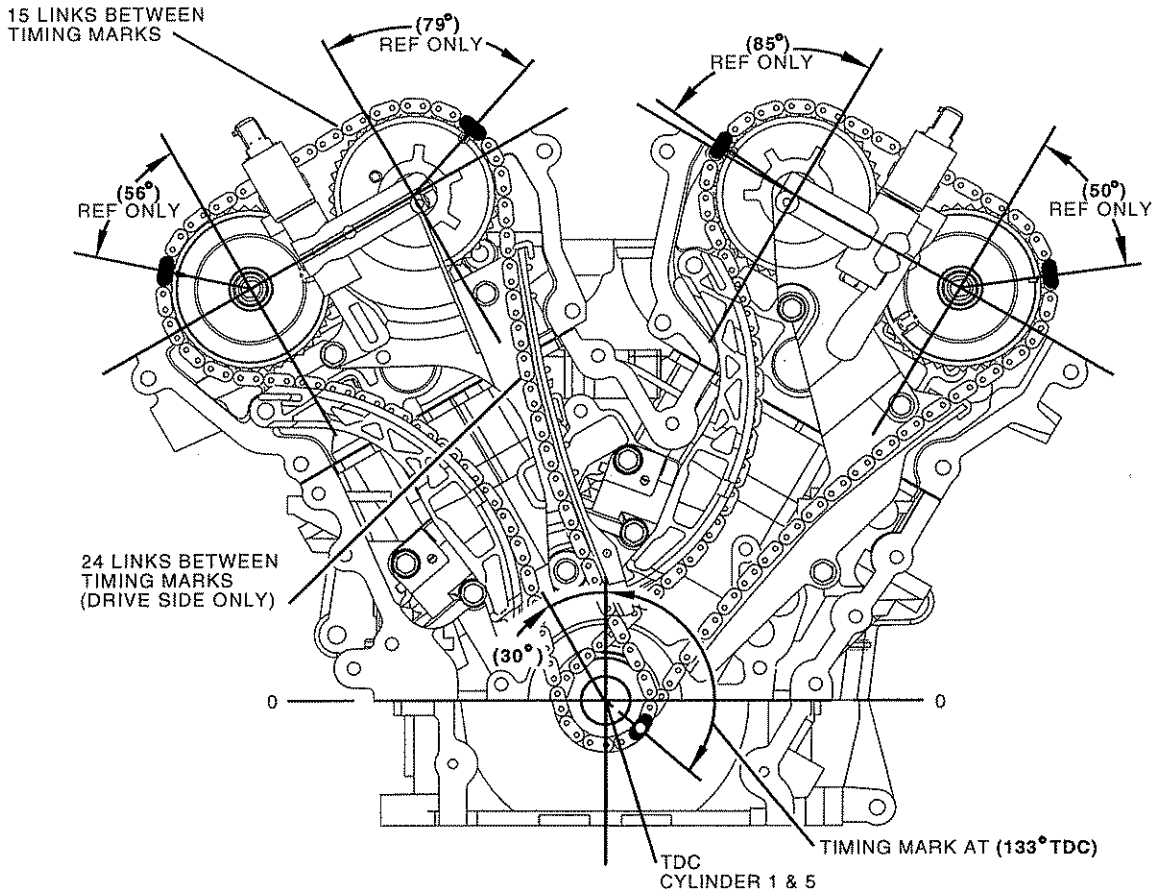
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CRANKSHAFT, CAMSHAFT SPROCKETS AND TIMING CHAIN (LH) & (RH) TIMING MARK ALIGNMENT (SERVICE AND REPAIR ONLY)

X400 _____ SHOWN
DEW03/X203/X350 _____ TYPICAL

NOTE:
COPPER LINKS &
YELLOW MARK ON LINK

NOTE:
TYPICAL ALIGNMENT WHEN PROPERLY INSTALLED AT TDC



CAM TIMING (MOST OPEN POSITION)

ENGINE	INTAKE	EXHAUST
2.0L	132°	113.5°
2.5L/3.0L	122°	113.5°

030901

SECTION - D

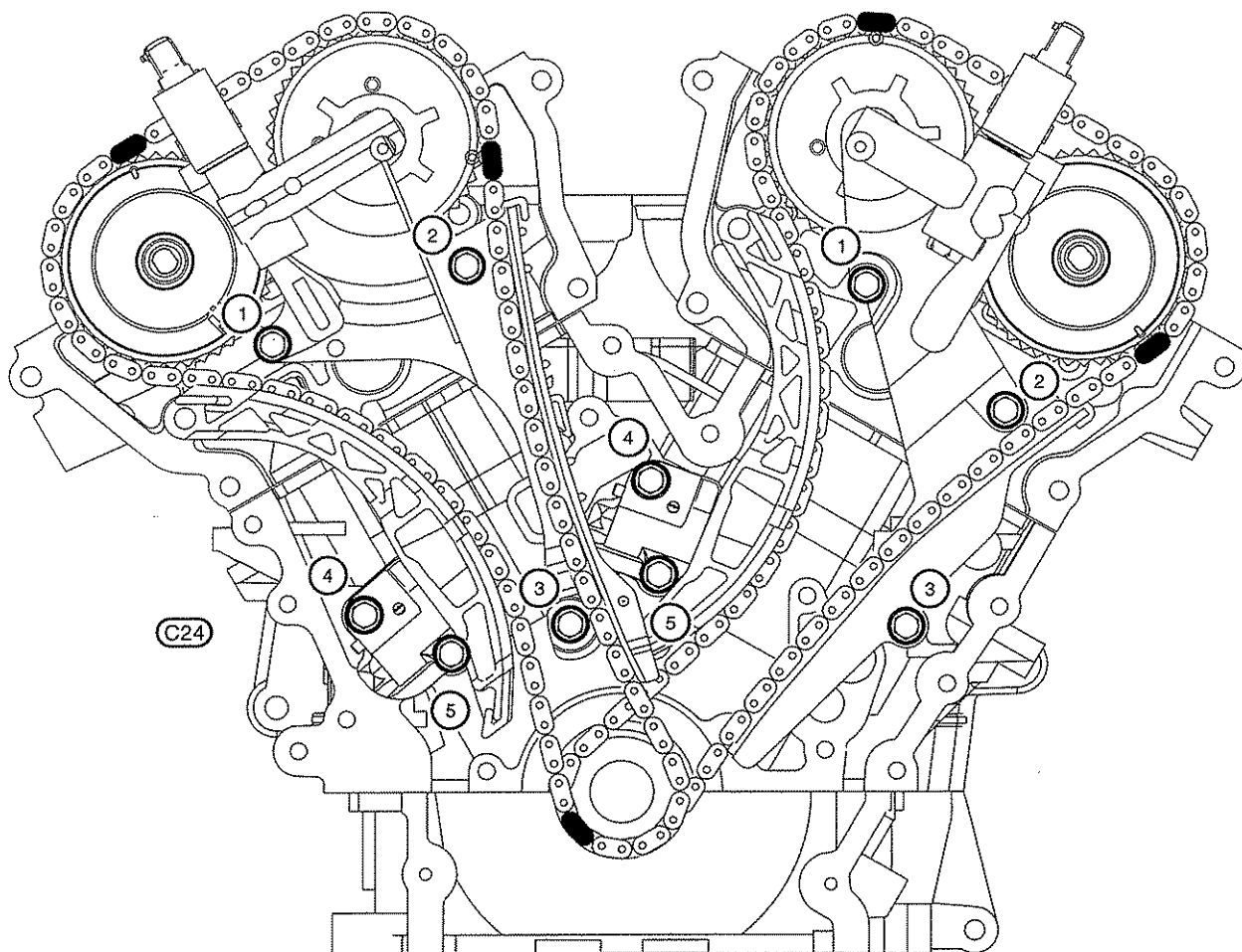
REL NE01-E11320306-000	MODEL 2003 2.0L / 2.5L / 3.0L-4V DAMB	DATE 020509	LAST FRAME 80
<i>Ford Motor Company</i> V-ENGINE ILLUSTRATION	NO. ∇ IL3W9E-030002-A0543F	REV ---	FRAME 25B CONTD 25C

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TIMING CHAIN COMPONENTS (FINAL TORQUE)



TORQUE PROCEDURE FOR VCT SOLENOID HOUSING ASY BOLTS

PRODUCTION METHOD (MULTI-SPINDLE)

1. AFTER ZERO TORQUE ASSEMBLY REMOVE TENSIONER PULL PIN (SEE FRAME 25A)
2. TORQUE ① TO (20-30 Nm)
3. RUNDOWN TORQUE ② & ③ SIMULTANEOUSLY TO (20-30 Nm)
4. TORQUE ④ & ⑤ TO (20-30 Nm)

SINGLE WRENCH METHOD (SERVICE - REPAIR)

1. AFTER ZERO TORQUE ASSEMBLY REMOVE TENSIONER PULL PIN (SEE FRAME 25A)
2. TORQUE ① TO (20-30 Nm)
3. TORQUE ② TO (20-30 Nm)
4. TORQUE ③ TO (20-30 Nm)
5. TORQUE ④ & ⑤ TO (20-30 Nm)

030901

SECTION - D

REL NE01-E11433990-000	MODEL 2003 2.0L / 2.5L / 3.0L-4V DAMB	DATE 030217	LAST FRAME 80
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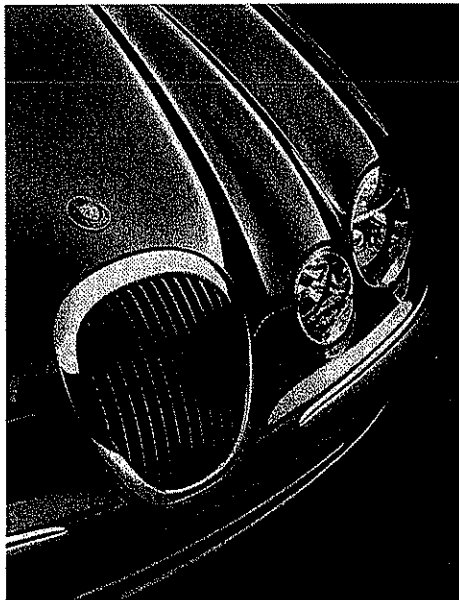
	V-ENGINE ILLUSTRATION NO. ▽ IL3W9E-030002-A0543F	REV C23	FRAME 25C	CONTD 26
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AJ-V6 ENGINE



- 1 ENGINE OVERVIEW
- 2 ENGINE COMPONENTS
- 3 LUBRICATION AND COOLING
- 4 CRANKCASE VENTILATION
- 5 ACCESSORY DRIVES
- 6 MECHANICAL DIAGNOSIS
- 7 ENGINE DISASSEMBLY
- 8 ENGINE ASSEMBLY
- 9 ENGINE SPECIFICATIONS



10 (1)

11 (1)

12 (1)

13 (1)

14 (1)

15 (1)

ENGINE SPECIFICATIONS

Configuration	–	60° V6
Displacement	–	2967cc (181 cu. in)
Bore	–	89.0 mm (3.504 in)
Stroke	–	79.5 mm (3.130 in)
Compression ratio	–	10.5:1
Cylinder head	–	2 overhead camshafts per bank, 4 valve per cylinder
Firing order	–	1-4-2-5-3-6
Maximum power	–	240 BHP at 6800 RPM
Maximum torque	–	300 Nm (221 lbft) at 4500 RPM
Weight	–	174 kg (384 lbs)

Lubricants, Fluids, Sealers and Adhesives

Specification

Engine oil, SAE 5W-30	–	WSS-M2C-912A
Engine assembly lubricant	–	SQM-2C9003 AA EP90
Sealant	–	WSS M4G 320-A3
Spark plug grease	–	'Neverseize' ESE M12 A4A
Hose assembly surfactant	–	ESE-M99 B144-B

Capacities

Engine oil, initial fill	–	5.5 litres
Engine oil, service fill with filter change	–	6.0 litres
Coolant	–	10.5 litres

For Technical data and torque specifications refer to latest JTIS: Powertrain, General Information and Specifications 303-01A.

